

SURPLUS RADIO CONVERSION MANUAL

VOLUME III

Conversion of

701-A

AN/APN-1

AN/CRC-7

AN/URC-4

ARA

BC-442, 453-455, 456-459, 603

696, 950, 1066, 1253

CBY-29125, 50083, 50141,

52208-11, 52232, 52302-09

FT-241A (for crystal filter)

MBF (COL-43065)

MD-7/ARC-5

R-9/APN-4

R23-R28/ARC-5

RAT, RAV

RM-52 (53)

RT-19/ARC-4

SCR-274N

SCR-522

T-15/ARC-5 to T-23/ARC-5

SEE TABLE OF CONTENTS ON PAGE 4

For

Amateur, Novice, Technician

and

Citizen's Radio Service

Just like *Ol' Man River* surplus equipment keeps rolling along. The supply waxes and wanes, but never completely dries up. Untold amounts of equipment are snapped up by "surplus hounds" only to be replaced by new, larger amounts of equipment arriving from unknown locations. Surely there must be some huge, hidden factory turning out tons of surplus equipment each day which will be sold to hams and others at bargain prices!

Modifying surplus equipment to fit the needs of the Amateur or Citizen Radio fan is interesting and exciting work. The high quality of most surplus equipment cannot be matched by commercial equipment selling at many times the cost of the surplus item. The converted surplus item can be made a piece of high-grade "ham" equipment at a money saving price!

However, every silver lining has a cloud. Some pieces of surplus equipment do not have schematic diagrams. Many items are modified from the original diagram, making the conversion process akin to a crossword puzzle. Other items are not worth the time to convert them! The enthusiast "surplus hound" must choose wisely and well when he buys, and must be adept at improvisation and "make-do."

Because of the time required to enter into personal correspondence, and because of the rapid and chaotic changes in the surplus market (and surplus equipment) it is impossible for the editors of this Manual to answer questions relating to conversions of equipment, to requests for schematics, or for purchasing information. The reader is referred to CQ magazine, which runs a surplus column. This column often contains answers to the perplexing questions which may confront the "surplus hound."

Good luck, and may your conversions always work!

Special thanks are due the Arrow Sales Company, North Hollywood, California for the use of several difficult-to-locate schematics.

SURPLUS RADIO CONVERSION MANUAL

VOLUME III

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Editor

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SURPLUS RADIO CONVERSION MANUAL

VOLUME III

LIST OF EQUIPMENT on which data is given in this volume

T-15 to T-22/ARC-5 BC-456 to 459 & 696 SCR-274N series CBY-52000 series DY-8 or DY-2A/ARR-2 DM-34D BC-453 BC-455 BC-603 (SCR-508, 528, 538) AN/APN-1 AN/CRC-7 AN/URC-4 (RT-159) MD-7/ARC-5 BC-442 RM-52, 53 FT-241A T-23/ARC-5 BC-458 (SCR-274N) WE-701-A BC-1253 BC-1066 R-9/APN-4 MBF/COL-43065 R-28/ARC-5 RT-19/ARC-4 BC-624 (SCR-522) BC-312 series BC-342 series BC-348 series BC-375/BC-191 AN/ART-13 LM AN/APT-5 CPR-46ACJ (ASB-5) BC-659 BC-1335A AN/ARR-2 AN/APA-10 AN/APT-2	Transmitters/Receivers 5 and 41 Dynamotors 11 Dynamotors 13 Receiver 14 Receiver for Citizens' Service 17 Receiver for Citizens' Service 18 Altimeter, as Transmitter 19 Transmitter/Receiver 22 Transmitter/Receiver as Handie-Talkie 28 Modulator 29 Relay for antenna changeover 30 Telephone Unit as phone patch 30 Crystals to make crystal filter 31 Transmitter, to 50 or 144 Mc. 31 Transmitter, conversion to S.S.B. 37 W. E. Tetrode Tube 42 Transmitter as radio control receiver 43 Receiver 43 Receiver 46 Transmitter/Receiver 46 24-volt Dynamotors to 115 v.a.c. motors 49 Receiver, Adding Variable Tuning Control 49 Receiver/Transmitter for 2 meters 52 Transmitter, TVI-proofed 60 Receivers 63 Receivers 63 Receivers 67 As Modulator 69 Autotune Transmitter 70 Power Supply for LM Frequency Meter 76 Radar Set schematic diagram 77 Receiver schematic diagram 78 Receiver/Transmitter schematic diagram 80 Receiver/Transmitter schematic diagram 82 Receiver schematic diagram 85 Panoramic Adapter schematic diagram 86 Radar Set schematic diagram 88
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THE RADIO HANDBOOK

THE RADIOTELEPHONE LICENSE MANUAL

SURPLUS RADIO CONVERSION MANUAL, VOLUME I

SURPLUS RADIO CONVERSION MANUAL, VOLUME II

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THE WORLD'S TELEVISION TUBES (BRANS' TELEVISION TUBES VADE MECUM)

THE WORLD'S EQUIVALENT TUBES (BRANS' EQUIVALENTS TUBE VADE MECUM)

The "Command" Sets

The "Command" Sets are probably the most popular pieces of radio equipment on the surplus market. Designed in 1938, they were produced in prodigious quantities for over a decade for the Army, the Navy, and the Air Force. The various items of equipment that make up a complete set form a multi-channel radio transmitting and receiving package for use on airplanes equipped with a 24 volt d.c. power source. The equipment is designed to transmit and receive voice, tone modulated, or continuous wave signals. Included in the equipment are various receivers, transmitters, modulators, and auxiliary items, tabulated in figure 1.

The basic circuit for all Command transmitters is shown in figure 2. A master oscillator excites a pair of beam power amplifier tubes connected in parallel. The master oscillator and power amplifier tuning capacitors are ganged for simplification of controls. A quartz crystal resonator (Y-50) is supplied with each transmitter for use with a "magic eye" tube to check frequency calibration at *one spot* on the dial. The crystal does not control transmitter frequency. Continuously variable coupling between the power amplifier tank circuit and the antenna circuit is achieved by a rotary loading coil (L-52) and a rotary link coil in the amplifier tank circuit.

The basic circuit for the Command receivers is shown in figure 3. All receivers are one-band superheterodynes, and except for L-C elements forming the r.f. and i.f. tuned circuits, they are essentially alike electrically and physically. Each receiver employs six metal 12 volt tubes.

All Command equipment is designed to mount in racks which make electrical interconnections via built-in plugs. In general, the racks for one series of equipment are not interchangeable with racks of other series, as the plug sizes and pin connections differ for the different branches of the Armed Forces. The use of the racks is not necessary, however, for amateur service.

The following information concerns the adaptation of the Command equipment for amateur use. *Additional conversion information for this popular equipment is given in Volumes I and II of this surplus conversion series.* The material included herewith is new, and does not duplicate material given in the previous manuals.

Converting the Command Receiver to Six Meters

Technicians and v.h.f. operators are interested in a method of converting the Command receivers for v.h.f. operation. The conversion involves constructing a power supply, rewinding the receiver coils, and replacing a tube. This conversion may be done with any receiver, but the use of the 3-6 Mc. receiver is recommended as the i.f. bandwidth is about optimum for general usage.

Remove the top covers and the bottom plate, saving the screws. Clean off the rear area of the receiver where the dynamotor was mounted and wire in the power supply shown in figure 4. Note that the two filament windings of the transformer must be correctly phased to produce 11.6 volts, a.c. The 12 volt tubes operate perfectly at this voltage. Make sure the receiver works on a.c. before you start the rest of this conversion.

Now, remove the coils by taking out the screws on each side of the receiver case that hold the assembly. Lift out the triple coil can and remove the 12 screws holding the coils in the cans. Remove the coils from the base and clean the terminals. Discard the original coils. Wind the self-supporting coils shown in figure 5. Reassemble the coils in the shields and replace the unit in the receiver.

Next, remove the 12SK7 r.f. tube (immediately behind the tuning capacitor) and replace it with a WE-717A, available at any large surplus store. (This tube is an octal based 6AK5, and has the same pin connections as the 12SK7). Rewire the "hot" filament pin to the six volt winding of the filament transformer, as shown in figure 4.

Inject a 50 Mc. signal into the receiver, holding the signal level down to prevent receiver overload. Adjust the oscillator padding capacitor C-4E, atop the tuning capacitor until the 50 Mc. signal appears at 5.7

"COMMAND" TRANSMITTERS

FREQ. RANGE (MC)	NOMENCLATURE			DESIGN MODIFICATION
	JOINT ARMY-NAVY (JAN)	SIGNAL CORPS (BC)	NAVY (ATA)	
2.1-3.0	T-18/ARC-5	—	CBY-52232 CBY-52305	— A
3.0-4.0	T-19/ARC-5	BC-696	CBY-52208 CBY-52306	— A
4.0-5.3	T-20/ARC-5	BC-457	CBY-52209 CBY-52307	— A
5.3-7.0	T-21/ARC-5	BC-458	CBY-52210 CBY-52308	— A
7.0-9.1	T-22/ARC-5	BC-459	CBY-52211 CBY-52309	— A
0.5-0.8	T-15/ARC-5	—	CBY-52302	— A
0.8-1.3	T-16/ARC-5	—	CBY-52303	— A
1.3-2.1	T-17/ARC-5	—	CBY-52304	— A
100-156	T-23/ARC-5	BC-950	—	— B
MODUL. UNIT	MD-7/ARC-5	BC-456	CBY-50083 CBY-50141	— A
ANTENNA RELAY	—	BC-442	CBY-29125	—

NOTES: A - PLATE AND SCREEN MODULATED.
B - MODULATOR INCLUDED IN TRANSMITTER
C - PLATE CIRCUIT OF P-A IS SHUNT-FED IN JAN MODELS

Figure 1
CHART OF VARIOUS MODELS OF
"COMMAND" TRANSMITTERS

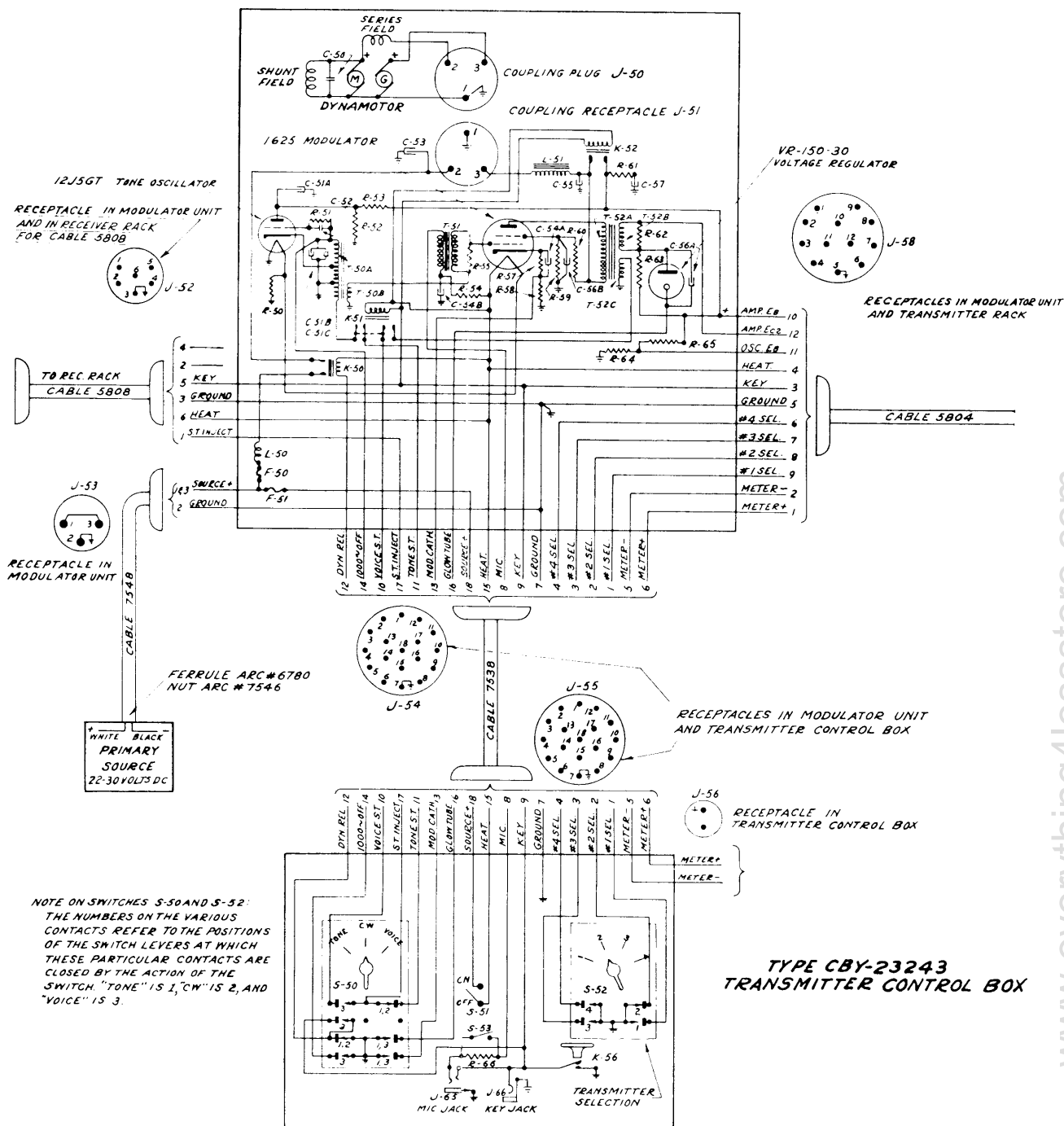
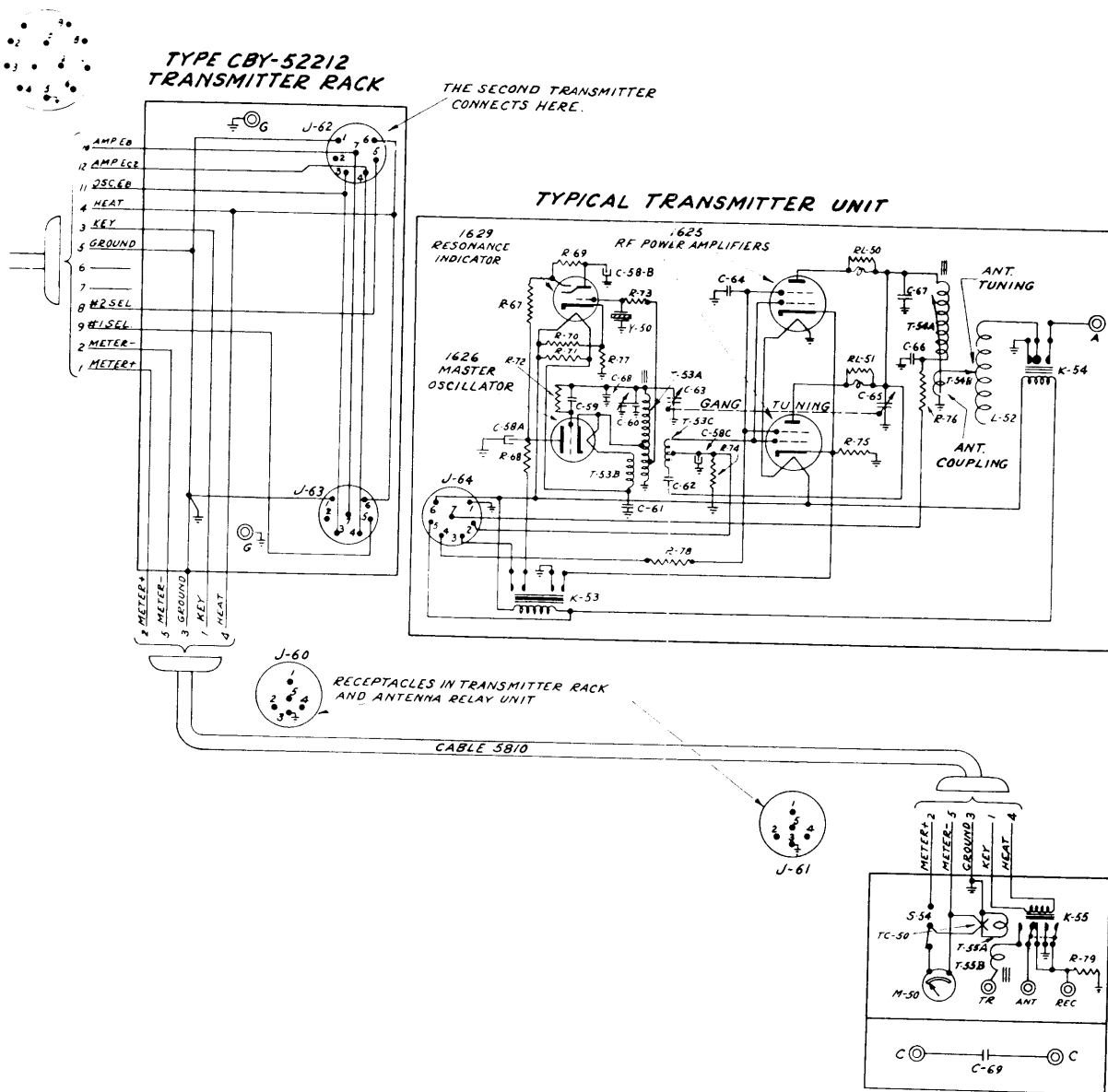


Figure 2-A
SCHEMATIC, "COMMAND" TRANSMITTER, MODULATOR AND
CONTROL BOX (ATA-TYPE PLUGS).

TYPE CBY-50083 MODULATOR UNIT WITH
TYPE CBY-21626 TRANSMITTER DYNAMOTOR UNIT

NOTES:

1. ALL RELAYS SHOWN IN NON-ENERGIZED POSITION.
2. ALL COUPLING PLUGS AND RECEPTACLES SHOWN AS VIEWED FROM THE OUTSIDE. ALL PLUGS AS VIEWED FROM THE CORDAGE END HAVE THE SAME ORIENTATION OF CONDUCTORS AS THAT SHOWN HERE FOR THEIR RESPECTIVE RECEPTACLES.



SWITCHES		TRANSFORMERS		MISCELLANEOUS	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
S-50	CHOICE OF EMISSION	T-50	tone osc	TC-50	THERMOCOUPLE
		T-51	MICROPHONE	M-50	ANT. CURRENT INDICATOR (LOCAL)
S-51	MAIN "ON-OFF" BATTERY LINE	T-52	MODULATION		
		T-53(A,B,C)	MASTER OSC	K-56	BUILT-IN KEY
S-52	TRANSMITTER SELECTION	T-54(A,B)	TRANS. OUTPUT	Y-50	CRYSTAL UNIT
		T-55(A,B)	ANT. CURRENT		
S-53	SHUNTS MIC. SERIES RESISTOR			F-50	20 A FUSE
				F-51	20 A FUSE
S-54	ANT. CURRENT-METER SWITCHING				

Figure 2-A
SCHEMATIC, "COMMAND" TRANSMITTER, MODULATOR AND CONTROL BOX (ATA-TYPE PLUGS).

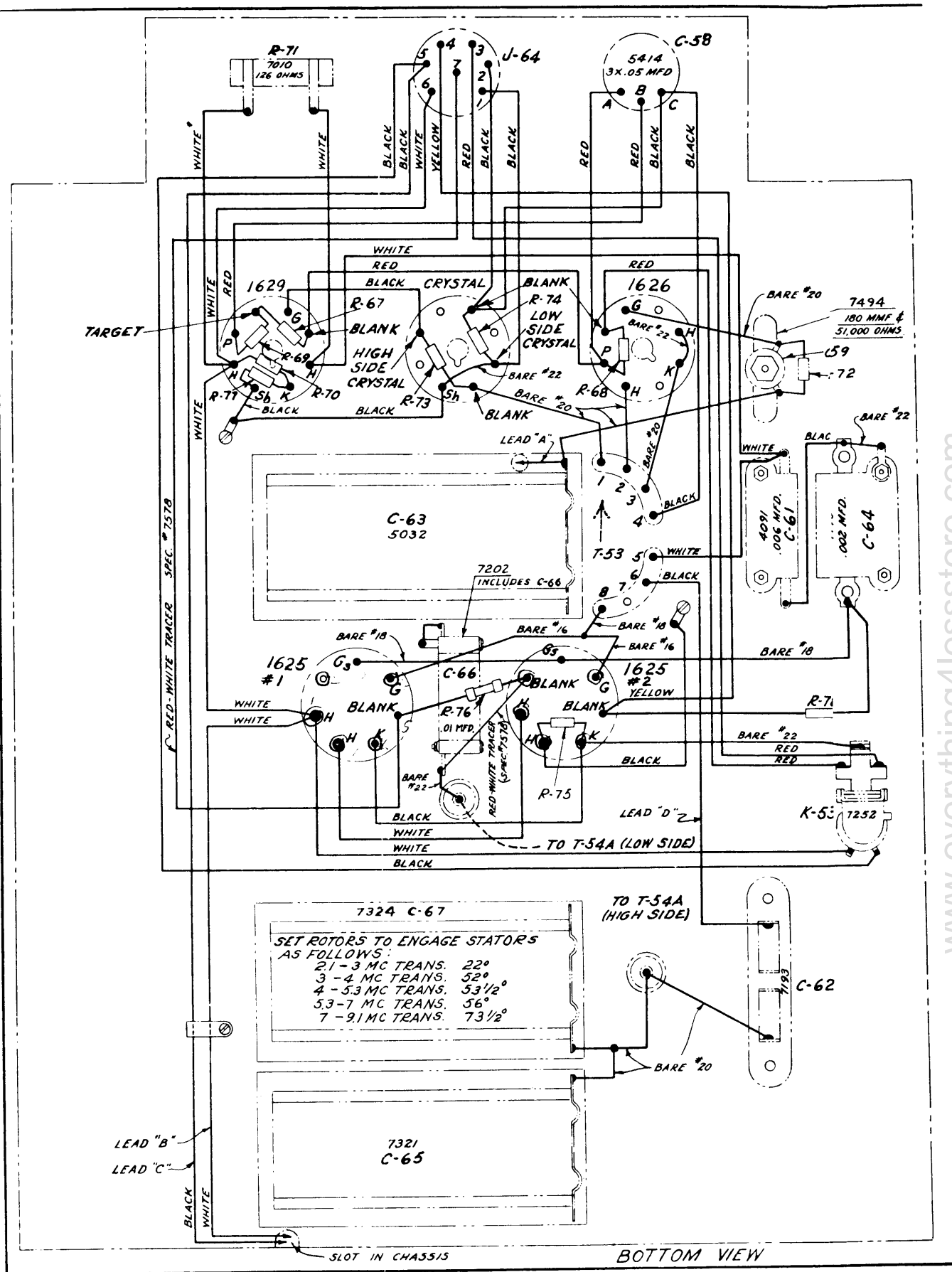


Figure 2-B
WIRING DIAGRAM AND PARTS PLACEMENT, "COMMAND"
TRANSMITTER.

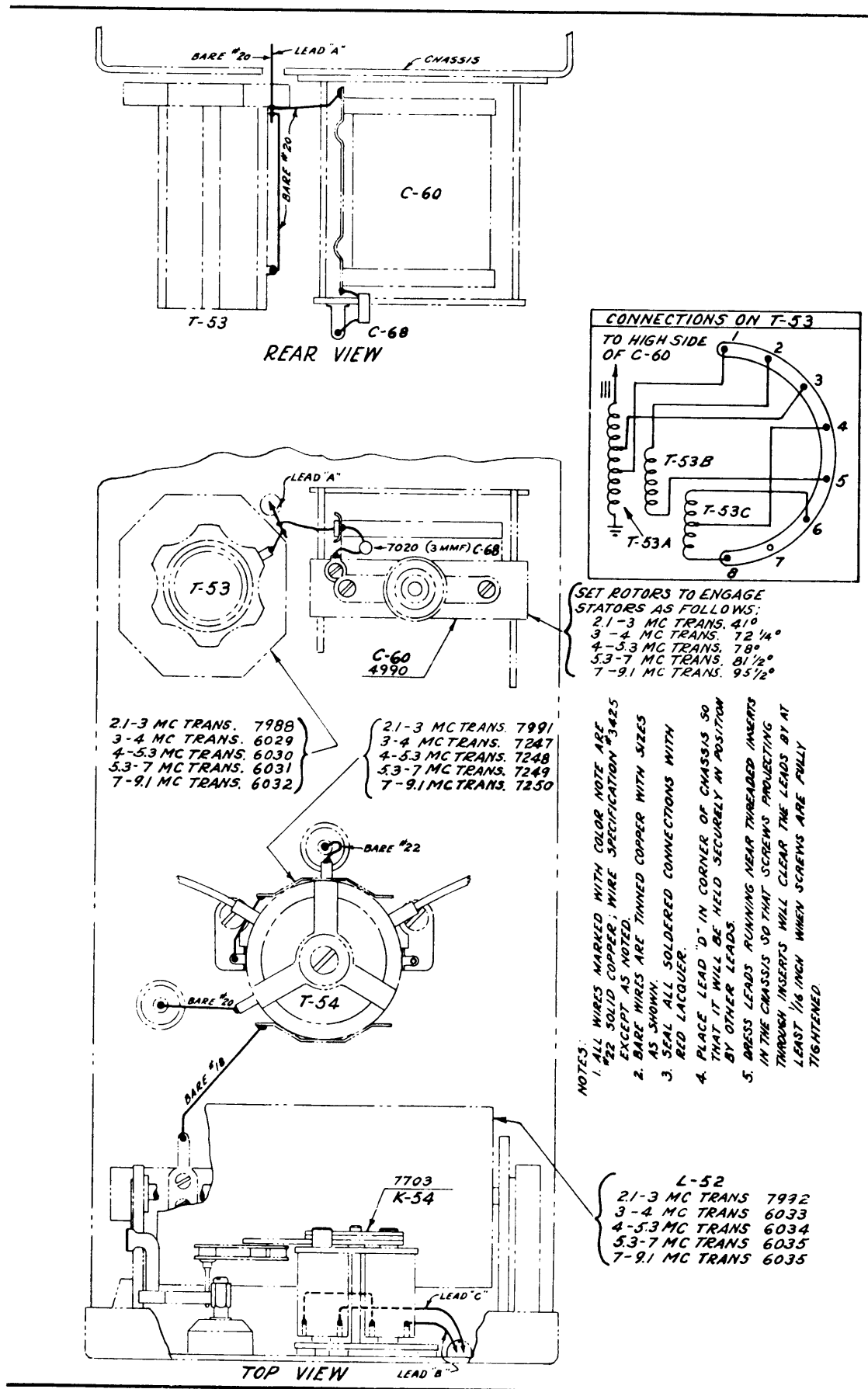
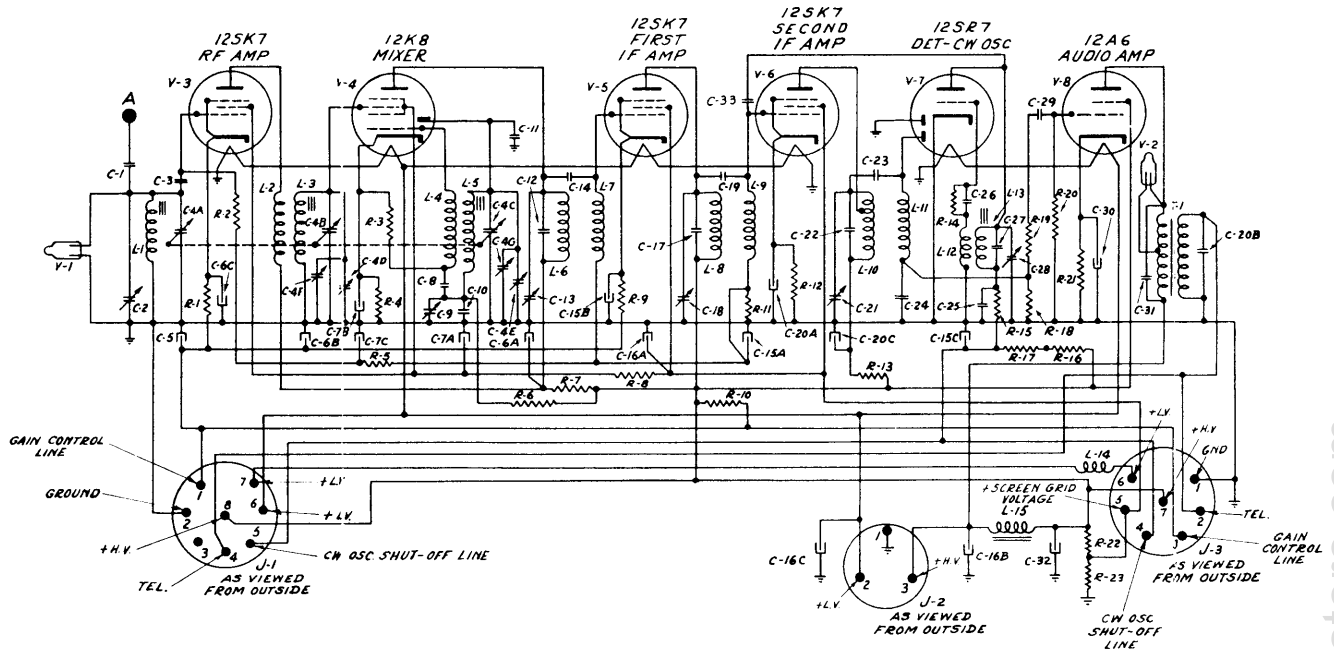


Figure 2-B
WIRING DIAGRAM AND PARTS PLACEMENT, "COMMAND"
TRANSMITTER.



CIRCUITS IN RF COIL SET, IF COUPLING UNITS, CW OSCILLATOR, AND OUTPUT TRANSFORMER. THE TERMINAL NUMBERS ON THESE UNITS AGREE WITH THOSE SHOWN AT THE CORRESPONDING LOCATIONS ON THE WIRING DIAGRAM.

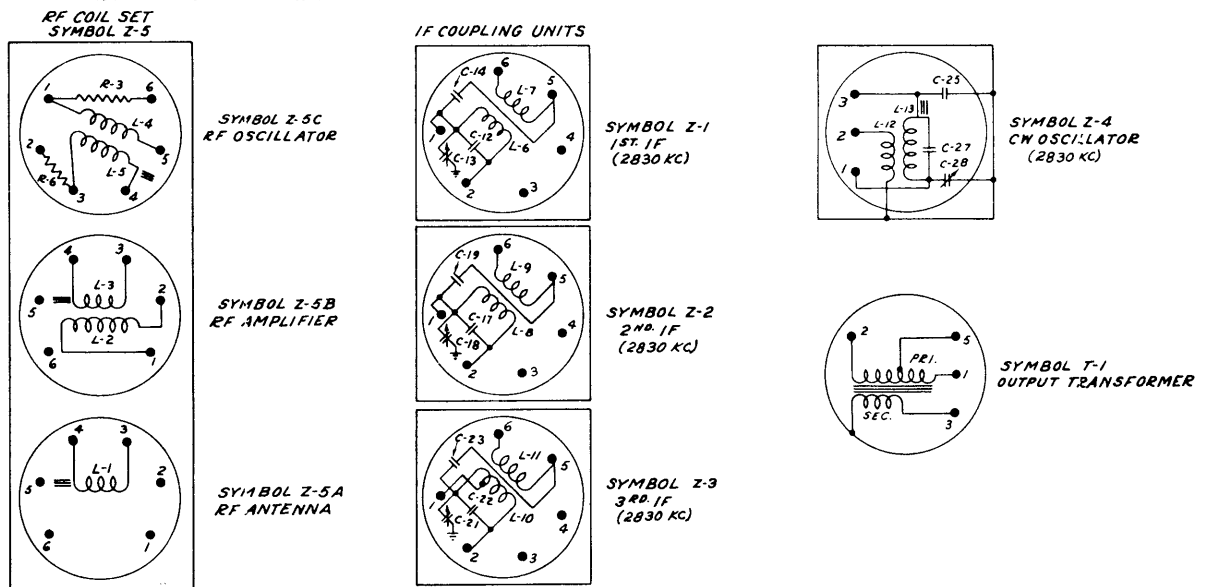
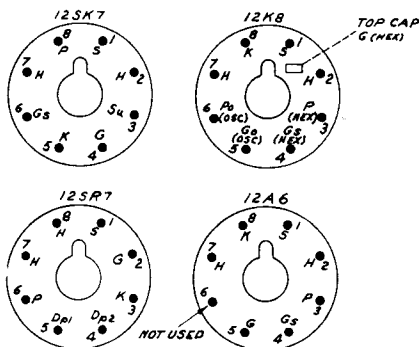


Figure 3-A
SCHEMATIC, "COMMAND" RECEIVER (ATA-TYPE PLUGS).

CAPACITANCES		INDUCTANCES		RESISTANCES	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	OHMS
C-1	8.5 MMF	L-1	ANT INPUT	R-1	620
C-2	15 MMF	L-2, L-3	RF AMP	R-2	2,000,000
C-3	100 MMF	L-4, L-5	RF OSC	R-3	51,000
C-4 (A1G)	GANG (62 MMF)	L-6, L-7	1N 1ST IF	R-4	620
C-5	3 MFD	L-8, L-9	1N 2ND IF	R-5	150,000
C-6 (A,B,C)	.05/.05/.05 MFD	L-10, L-11	1N 3RD IF	R-6	150,000
C-7 (A,B,C)	.05/.05/.05 MFD	L-12, L-13	CW OSC	R-7	200
C-8	200 MMF	L-14	RF CHOKE	R-8	200
C-9	40 MMF		112 MICRO-HENRIES	R-9	620
C-10	240 MMF			R-10	360,000
C-11	3 MMF	L-15	AF CHOKE	R-11	100,000
C-12	180 MMF		3 HENRIES	R-12	510
C-13	17 MMF			R-13	200
C-14	180 MMF			R-14	100,000
C-15 (A,B,C)	.05/.05/.05 MFD			R-15	5,100
C-16 (A,B,C)	.22/.22/.22 MFD			R-16	51,000
C-17	180 MMF			R-17	51,000
C-18	17 MMF			R-18	510,000
C-19	180 MMF			R-19	100,000
C-20 (A,B,C)	.05/.05/.05 MFD			R-20	2,000,000
C-21	17 MMF			R-21	1500
C-22	180 MMF			R-22	7000
C-23	180 MMF			R-23	7000
C-24	200 MMF				
C-25	.001 MFD				
C-26	100 MMF				
C-27	180 MMF				
C-28	34 MMF				
C-29	.006 MFD				
C-30	15 MFD				
C-31	.001 MFD				
C-32	5 MFD				
C-33	WIRING CAPACITANCE (LESS THAN 2 MMF)				

TUBE SOCKET TERMINALS
AS VIEWED FROM BOTTOM

TUBE TERMINAL CODE

S = SHELL	Gs = SCREEN GRID
H = HEATER	Gs(hex) = SCREEN GRID, HEXODE SECTION
K = CATHODE	Gc(osc) = CONTROL GRID, OSC SECTION
S4 = SUPPRESSOR GRID	P = PLATE
Dp1 = FIRST DIODE PLATE	P(hex) = PLATE, HEXODE SECTION
Dp2 = SECOND DIODE PLATE	Pc(osc) = PLATE, OSC SECTION
G = CONTROL GRID	Gc(hex) = CONTROL GRID, HEXODE SECTION

Figure 3-A (continued)

Mc. on the tuning dial. Retune the signal generator to 54 Mc. This should appear at 6 Mc. on the receiver dial. Peak up the mixer trimmer (on the side of the tuning capacitor) and the antenna trimmer on the front panel for maximum signal. Calibration may be varied by juggling the oscillator padding capacitor C-9 and the auxiliary oscillator capacitor C-4 on the side of the tuning capacitor. When the coverage is correct, the dial may be re-painted with white paint

and the new calibration marks placed on the surface with India ink.

A suitable "control panel" for the front of the receiver is shown in figure 6. Remove the auxiliary plug at the bottom of the front panel, knock off the knob and use the panel as a mount for the components.

Make a Novice Receiver for 40 and 80 Meters from the 3—6 Mc. Command Receiver!

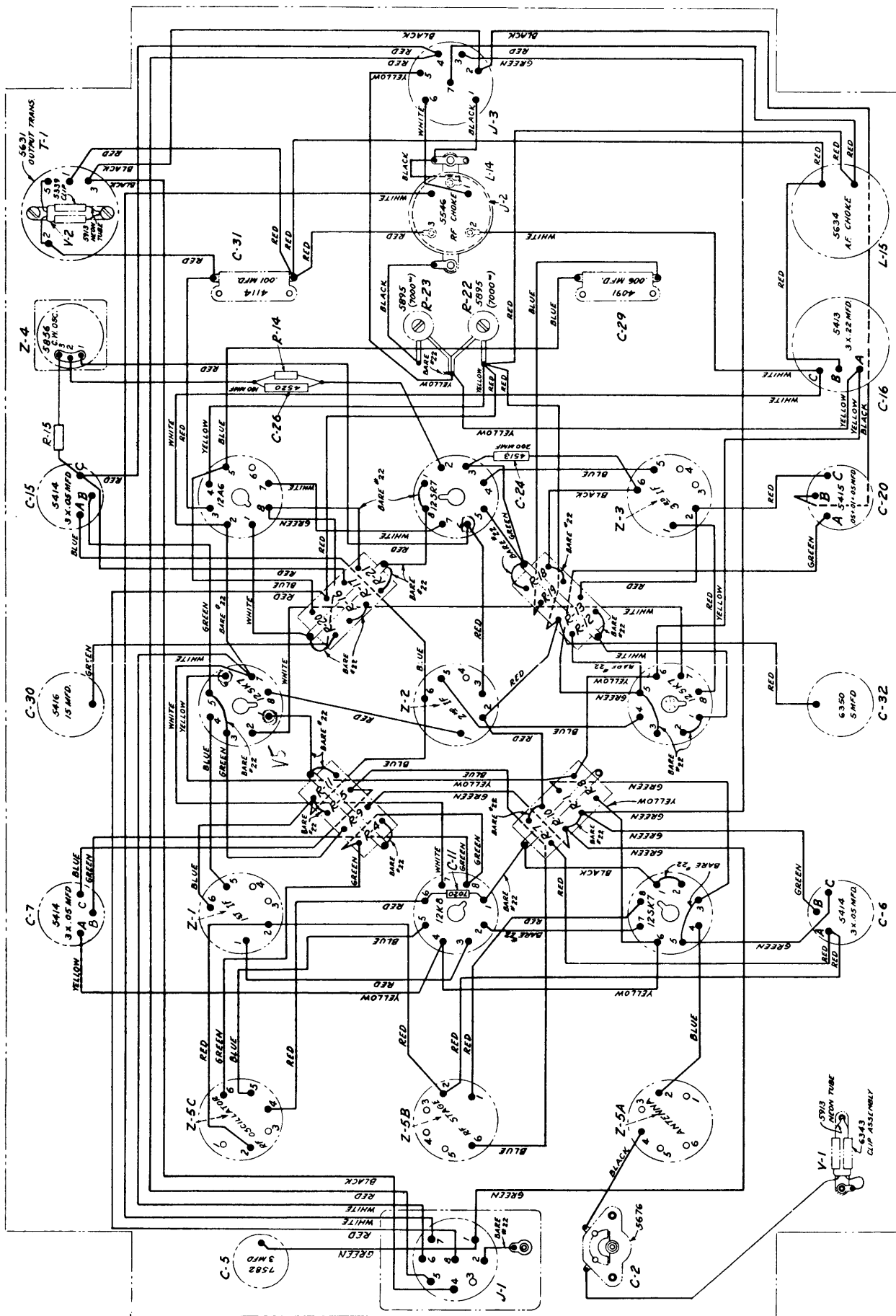
The 3—6 Mc. Command receiver "just misses" the 7 Mc. Novice amateur band. An excellent and easy-to-perform conversion of this receiver will permit it to cover both Novice bands! Simply remove the coil rack from the receiver, and remove the coils from the cans. Mark the coils so you can distinguish between them. With a pair of "needle-nose" pliers pull out the micarta clip that secures the powdered iron slugs within the coils. Remove the three slugs and discard them. Be careful not to damage the coil windings or the terminal connections. Reassemble the coils, solder all connections, and install the coil rack in the receiver.

Using a signal generator, set the 6 Mc. dial marking to a generator frequency of 7.4 Mc. by adjusting the high frequency oscillator padder (C-4G). Next, set the 3 Mc. dial marking to a generator frequency of 3.4 Mc. Go back to 7.4 Mc. and recheck this point. Re-set C-4-G slightly, if necessary. Peak up the mixer trimmer, and the antenna trimmer. The receiver will now tune the range of 3.4 Mc. to 7.4 Mc., covering both the 80 meter and the 40 meter Novice bands.

A Plug-in Power Supply for Your Command Receiver

Many amateurs and experimenters have a whole "stable" of Command receivers. Not only is it expensive to purchase power transformers for each receiver but it is very difficult to adapt a receiver converted in such a manner for mobile operation. Described herewith is a plug-in power unit that fits in the dynamotor space of the receiver. The supply can be easily removed and a converted dynamotor used for mobile operation.

First, wire all filaments in parallel for 12 volt operation. Locate a Command receiver dynamotor (DY-8, or DY-2A/ARR-2) and remove the base mounting plate. Discard the dynamotor. Remove everything from the base plate, including the sliding clips, but retain the three pin connector. Mount the new power transformer, rectifier tube, socket, and filter capacitor as shown in figure 7A. Note that the capacitor and rectifier tube socket are mounted on ¼" metal spacers. The transformer is mounted on ¼" metal spacers so that the leads will not be pinched between the core and the plate. It is only necessary to drill holes in the base plate for the four metal spacers and the 6-32 screws that secure the power transformer. The line cord is held in place with a cable clamp secured under one of the transformer mounting bolts. A switch may be placed in the line cord.



WIRING BELOW TUBE DECK

Figure 3-B
WIRING DIAGRAM, "COMMAND" RECEIVER.

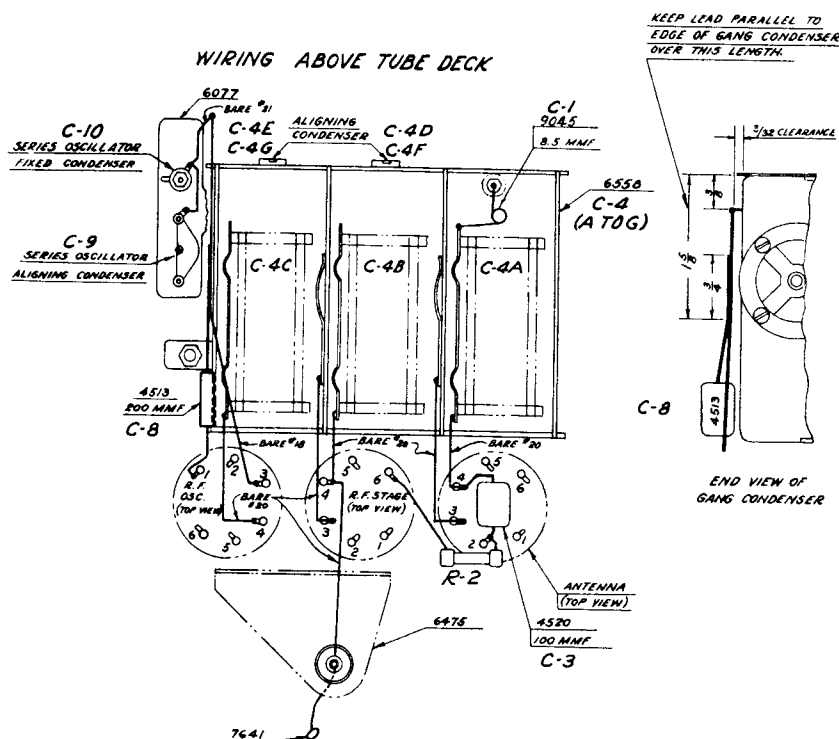


Figure 3-B (continued)

- NOTES:**
1. ALL WIRES MARKED WITH COLOR NOTE ARE #22 SOLID COPPER; WIRE SPECIFICATION #3425 EXCEPT AS NOTED.
 2. BARE WIRES ARE TINNED COPPER WITH SIZES AS SHOWN.
 3. SEAL ALL SOLDERED CONNECTIONS WITH RED LACQUER.
 4. TERMINAL NUMBERS SHOWN ARE FOR IDENTIFICATION PURPOSES. THEY DO NOT APPEAR ON THE EQUIPMENT EXCEPT ON TUBE SOCKETS AND OUTPUT TRANSFORMER.

The schematic of the supply is shown in figure 7B, and a photo of a typical supply, installed in a receiver is shown in figure 8.

A Twelve Volt Command Dynamotor for Mobile Service

It is often desirable to employ a Command receiver for mobile or Field day operation. When using the a.c. power pack described in the previous section, the receiver may be easily powered with a 12-volt dynamotor. Although 12-volt dynamotors for Command receivers have occasionally appeared on the surplus market, they are not generally available. The DM-34D (part of the BC-603 equipment) is quite common, however, and is the same physical size as a Command set dynamotor, delivering 220 volts at 80 ma., with a primary drain of 12-14 volts at 2.8 amperes. It may be used with the Command receiver with a simple conversion.

Obtain a 28-volt Command receiver dynamotor. Remove the mounting base, complete with sliding latches, socket, and ground lug. Discard the dynamotor. Now, cut the DM-34 mounting brackets to

2-9/16" so that the brackets will just fit inside the up-turned flanges of the Command dynamotor base. Drill a small hole in each DM-34 bracket and a corresponding hole in the base so that the dynamotor may be

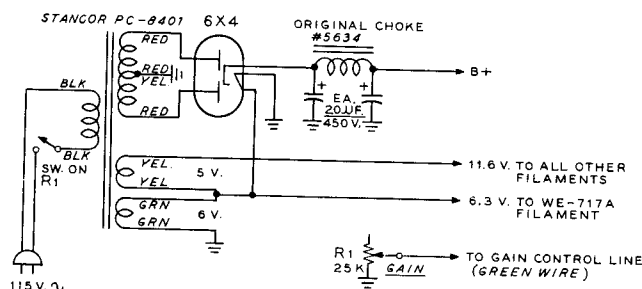


Figure 4
A.C. POWER SUPPLY FOR COMMAND RECEIVER. Power transformer delivers 235-0-235 volts at 40 ma., 5 volts at 2 amperes, and 6.3 volts at 2 amperes. If 6.3 volt winding has two center-tap wires, cut them short and solder them together, then tape.

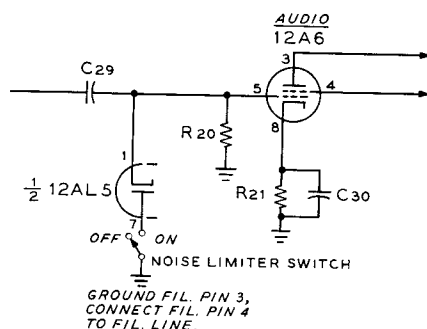


Figure 9
SCHEMATIC, NOISE LIMITER
FOR COMMAND RECEIVER.

The coil rack is removed and the following alterations are made to the coils:

- 1—Remove 210 turns from the antenna coil (L-1).
- 2—Remove 500 turns from the mixer coil primary (L-2).
- 3—Remove 220 turns from the mixer coil secondary (grid).
- 4—Remove 195 turns from the oscillator coil secondary (L-5).

Do not remove any turns from oscillator coil primary (the grid winding). When completed, replace the coil rack. The receiver will now tune the frequency range of 550 kc.—1600 kc. Adjust high fre-

quency alignment with the oscillator shunt padders (C-4E, C-4G) on the variable tuning capacitor. Track the low frequency end of the band with the adjustable powdered iron slug cores in the three coils, plus the oscillator series padder (C-9) on the end of the tuning capacitor.

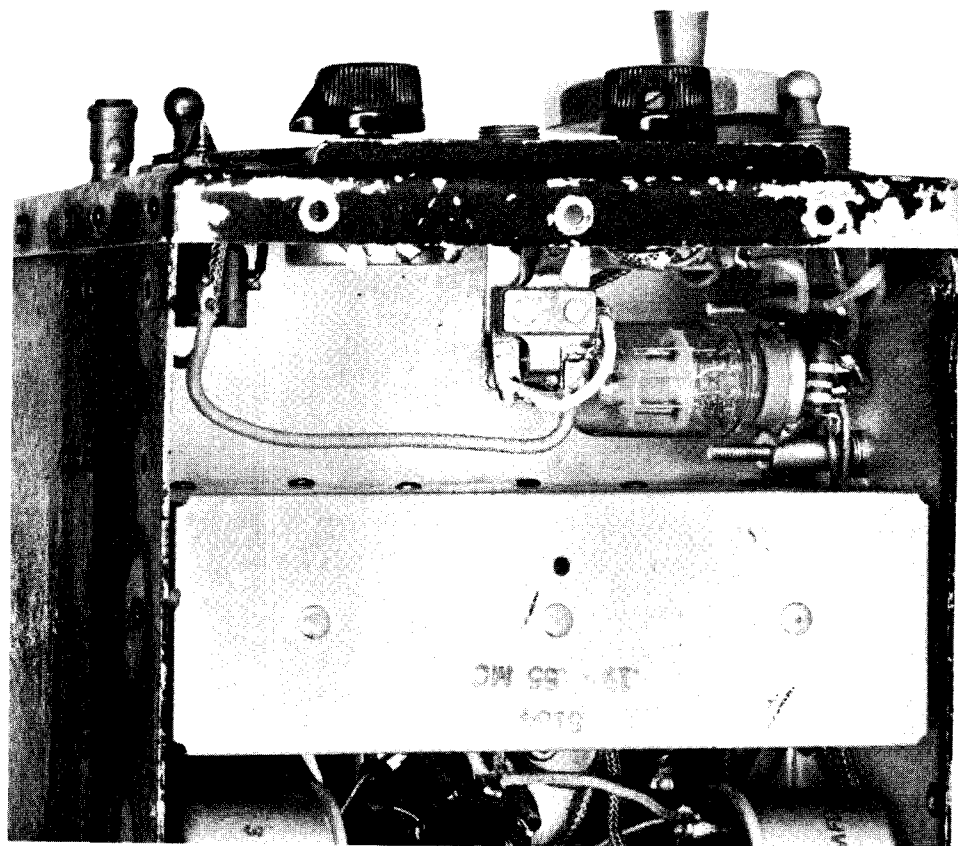
A Noise Limiter for Your Command Set

Tired of automobile QRM or static on your Command set? A very simple but effective noise limiter can be connected as shown in figures 9 and 10. A 12AL5 tube is used. The cathode of one-half of the diode is connected to the 12A6 control grid. The grid of the 12A6 is slightly negative, so the diode does not conduct; however, when a noise peak arrives (or a strong audio peak) the diode conducts and shorts the grid circuit out to ground. The limiting action is as good as the more complicated shunt-type limiter, but the audio distortion is a little higher. A switch may be incorporated to remove the limiter from the circuit when it is not required.

Automatic Volume Control for Your Command Set

Automatic volume control is extremely effective in preventing distortion or overloading on strong local signals. It is very simple to add a.v.c. to the Command receivers. (Note: A few "ARC" series receivers have a.v.c. incorporated). All the essential a.v.c. components are incorporated in all receivers, but there is

Figure 10
The 12AL5 noise limiter tube may be placed in the under-chassis area behind the panel of the receiver.



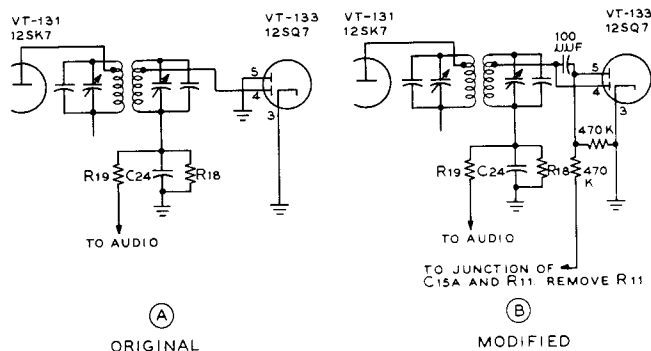


Figure 11
SCHEMATIC, A.V.C. CIRCUIT FOR
"COMMAND" RECEIVER.

no connection between them. The purpose of this conversion is to provide a.v.c. action to the r.f. and i.f. amplifier stages by completing the a.v.c. circuit. It requires two additional resistors and a capacitor. Refer to figures 11A and 11B. First, unground pin 5 of the 12SQ7 (VT-133). Connect the 100 μ fd. capacitor across pins 4 and 5 of the tube socket. Connect the 470K resistor from pin 5 to an adjacent ground lug. Connect the second 470K resistor between pin 5 and the junction of C-15A and R-11. Remove R-11 from the circuit to increase the effect of the a.v.c. action.

A Built-in Speaker for Your Command Receiver

A small speaker may be mounted in the removable adapter plate in the front of the Command receiver. The "speaker" is the small receiver element in standard use in telephone handsets. It is only 1½" in diameter, and 11/16" thick. It is available on the surplus market, and identifiable by the letters HA-1 stamped on the face.

A blank aluminum plate replaces the original adapter plate. A hole is cut in the plate just large enough to clear the HA-1 unit. A second hole is made for the gain control, shown in figure 6.

If the b.f.o. switch is not used, placement of parts on the new plate is not critical. However, if a b.f.o. switch is desired it will be a tight squeeze to get the three components together on the new adapter plate.

A single layer of "Scotch" electrical tape is wrapped around the shell of the speaker to isolate it from

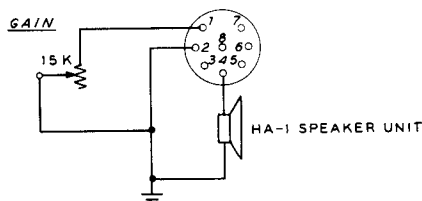


Figure 12
SCHEMATIC, HA-1 SPEAKER
FOR USE IN "COMMAND"
RECEIVER.

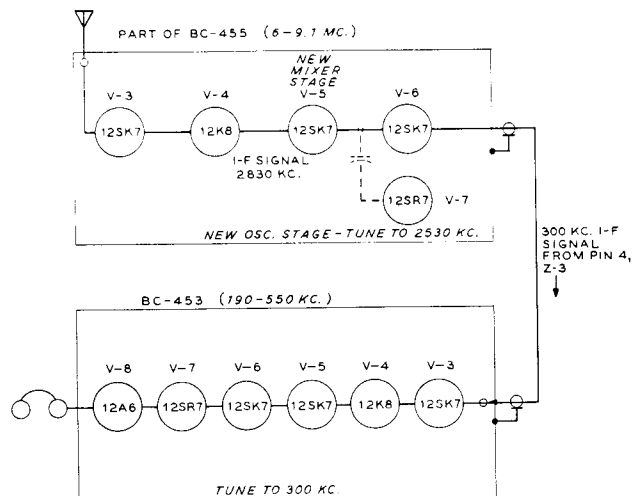


Figure 13
BLOCK DIAGRAM OF DOUBLE-CONVERSION AMATEUR BAND RECEIVER MADE FROM TWO "COMMAND" RECEIVERS. BC-455 serves as r.f. portion, and BC-453 serves as "i.f. strip."

the chassis, and after placing the speaker in the hole in the plate a second piece of tape is wrapped around the body of the speaker to hold the unit from slipping out of the hole.

Wire the positive side of the speaker directly to pin #4 of J-1 (the front plug in the back of the adapter plate). Mount the gain control. Wire the "hot" arm of the control to pin #2 of J-1, and the other side of the control to pin #1 of J-1. Finally, connect the other side of the speaker to ground. Screw the adapter plate to the front of the receiver, and you have a sensitive, clean-sounding speaker, audible many feet from the receiver. The complete wiring changes are shown in figure 12.

A "Double Conversion" Command Receiver for Single Sideband Reception

It is possible to combine two Command receivers to form a double conversion receiver, well suited for single sideband reception or selective c.w. reception. The BC-453 (190-550 kc.) and BC-455 (6-9.1 Mc.) receivers are used. A block diagram of the combination is shown in figure 13. The BC-455 tunes the 7 Mc. amateur band (or it may be modified for other bands as described later) and the intermediate frequency signal of this receiver (2830 kc.) is converted to 300 kc., within the tuning range of the BC453. The combination provides excellent sensitivity, selectivity, and freedom from bothersome "image" signals.

Only a portion of the BC-455 is used. The r.f. amplifier, mixer, and first i.f. stage function in the usual manner, and are unmodified. The second i.f. stage (12SK7) V-5 is changed into a mixer, and the b.f.o. section of the 12SR7 (V-7) is converted to a mixing oscillator. The 12A6 audio tube is removed.

The first step is to lower the frequency of the 12SR7 beat oscillator until it operates 300 kilocycles below the intermediate frequency of 2830 kc. The new frequency of oscillation is therefore 2530 kc. To effect this change, solder a 100 μ fd. mica capacitor between the plate (pin #5) and ground (pin #1) of the 12SR7 socket. The desired frequency of 2830 kc. may now be tuned by adjusting the b.f.o. trimming capacitor C-28 on the side of the receiver. Check the frequency by listening to it on a nearby receiver or frequency meter. The old b.f.o. has now been transformed into a suitable mixing oscillator.

The next step is to couple the new i.f. output frequency of 300 kc. (2830 kc. minus 2530 kc.) into the BC-453 which serves as the low frequency i.f. amplifier. Remove the third i.f. transformer from the BC-455 (transformer Z-3). Solder a 30K, 1-watt resistor between pin #1 and pin #2 of the i.f. socket. Solder a 100 μ fd. capacitor between pin #1 and pin #4, which is used as a tie-point terminal. Finally, cut a short length of shielded wire, long enough to reach from pin #4 to the antenna terminal of the BC-453. Solder the center conductor to pin #4 of i.f. transformer socket Z-3 and solder the shield to a nearby ground lug (pin #5 of 12SR7 socket). Connect the inner conductor to the antenna terminal of the BC-453, and ground the shield to the chassis of the second receiver.

Tune the BC-453 to 300 kc., and tune the BC-455 to 7 Mc. You can now tune in 40-meter signals by tuning either receiver. In general, tune the BC-455 to the edge of the amateur band, and then cover the band on the BC-453. The i.f. bandwidth of the high frequency receiver is broad enough to allow you to tune the BC-453 for 100 kilocycles or so without a drop in received signal strength. Use the b.f.o. in the BC-453 for s.s.b. or c.w. reception.

As an example, suppose you want to tune in a signal at 7150 kc. Set the BC-453 to 300 kc. and then tune the BC-455 to 7100 kc. Next, tune up 50 kc. on the BC-453, and you are "on the nose" at 7150 kc. In this way, you can read your frequency of reception to one or two kilocycles. Always remember to set the BC-453 tuning dial to 300 kc. for general tuning with the BC-455.

Converting the BC-455 for 20, 15, and 10 Meters

Conversion for Citizens Radio Service

It is possible to buy extra r.f. coil racks on the surplus market for the Command sets. To change bands, it is only necessary to rewind these racks, and then to use them as plug-in coils in your BC-455.

To rework a rack, the data of figure 14 may be used. You will need to borrow another receiver or frequency meter in order to listen to the mixer oscillator of the BC-455 during the tracking process. Remove the coils and rewind them to the specifications given in figure 14. You can check the approximate resonant

frequencies by placing the coils in the receiver (without the shields) and noting the resonant frequency on a grid-dip oscillator. Be sure to remove the iron core from the mixer and oscillator coils. When you have modified the coils, solder all connections, place them in the rack, and replace the rack in the receiver. Turn on the Command set, and then look for the signal of the high frequency oscillator in a nearby receiver. Adjust the trimming capacitors on the oscillator section of the tuning capacitor (C-4E, C-4G, and C-9) until the oscillator tuning covers the desired range. Finally, trimmers C-2, C-4D, and C-4F are adjusted for maximum strength of received signals. The last step is to cover the tuning dial with white enamel and recalibrate the high frequency bands with India ink directly on the dial face. Only one or two markings are required for each band, as the main tuning is done with the BC-453 dial. The 28 Mc. coil data, also applies to the 27 Mc. Citizens Radio Service.

"Hop-Up" Your Command Receiver for Improved High Frequency Reception

It is possible to boost the gain of the Command set and to materially improve reception on the 10, 15, and 20 meter ranges. To do this, the 12SK7 i.f. amplifier tubes are replaced with 12SG7 tubes, and the 12SK7 r.f. amplifier tube is replaced with a 12SG7. It is also necessary to lower the cathode bias resistor R-1 on the r.f. tube. Shunt R-1 with a 620 ohm, $\frac{1}{2}$ -watt resistor. In addition, bypass socket pin #5 to ground with a 0.01 μ fd. disc ceramic capacitor. To boost the gain of the i.f. amplifier, shunt the screen resistor (R-22) with a 10K, 10 watt resistor.

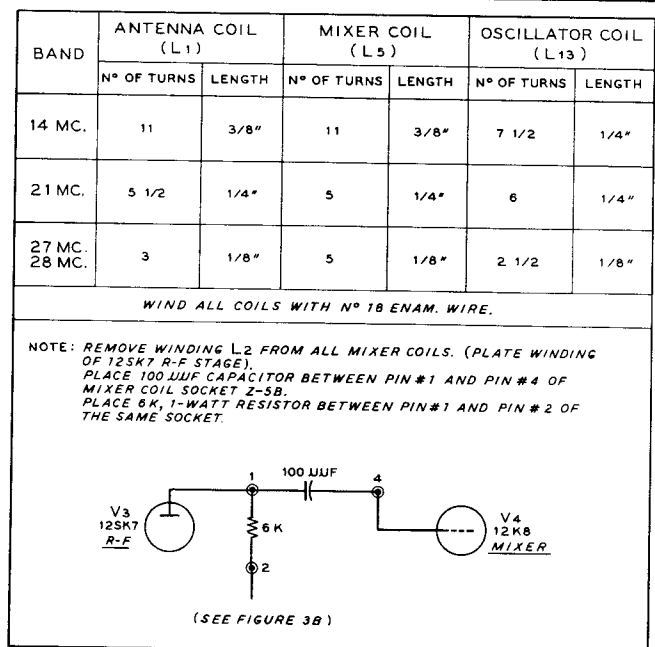


Figure 14
COIL DATA FOR CONVERTING BC-455 TO
14, 21, OR 28 Mc.

If the gain of the receiver is too high, instability may result. It can be eliminated by experimenting with the value of these two shunting resistors. Try 1000 ohms across R-1 and 15K across R-22 if the receiver shows signs of feedback or oscillation. See figure 3 for receiver schematic and parts placement.

**Conversion of the BC-603 to a
10-11-15 Meter AM/FM Receiver
(Ideal for the Citizen's Band!)**

The BC-603 f.m. receiver is a component part of Radio Sets SCR-508, 528, and 538. It provides f.m. reception over the range of 20-27 Mc., has a sensitivity of one microvolt, and 80 kc. bandwidth. An in-

termediate frequency of 2.65 Mc. is employed, and a self-contained audio amplifier provides 2 watts of power for a speaker, or 0.2 watts for headsets. On 12 volts the battery drain is 4 amperes. Properly converted, this inexpensive surplus item makes a good high frequency a.m./f.m. receiver. The original BC-603 schematic is shown in figure 16.

Adding An A.C. Operated Power Supply

The purchaser of the BC-603 should try to obtain both the 12-volt dynamotor (DM-34) and the 24-volt dynamotor (DM-36). The 28-volt unit is of little value, but the base makes an excellent foundation for the a.c. power supply. Remove all components from

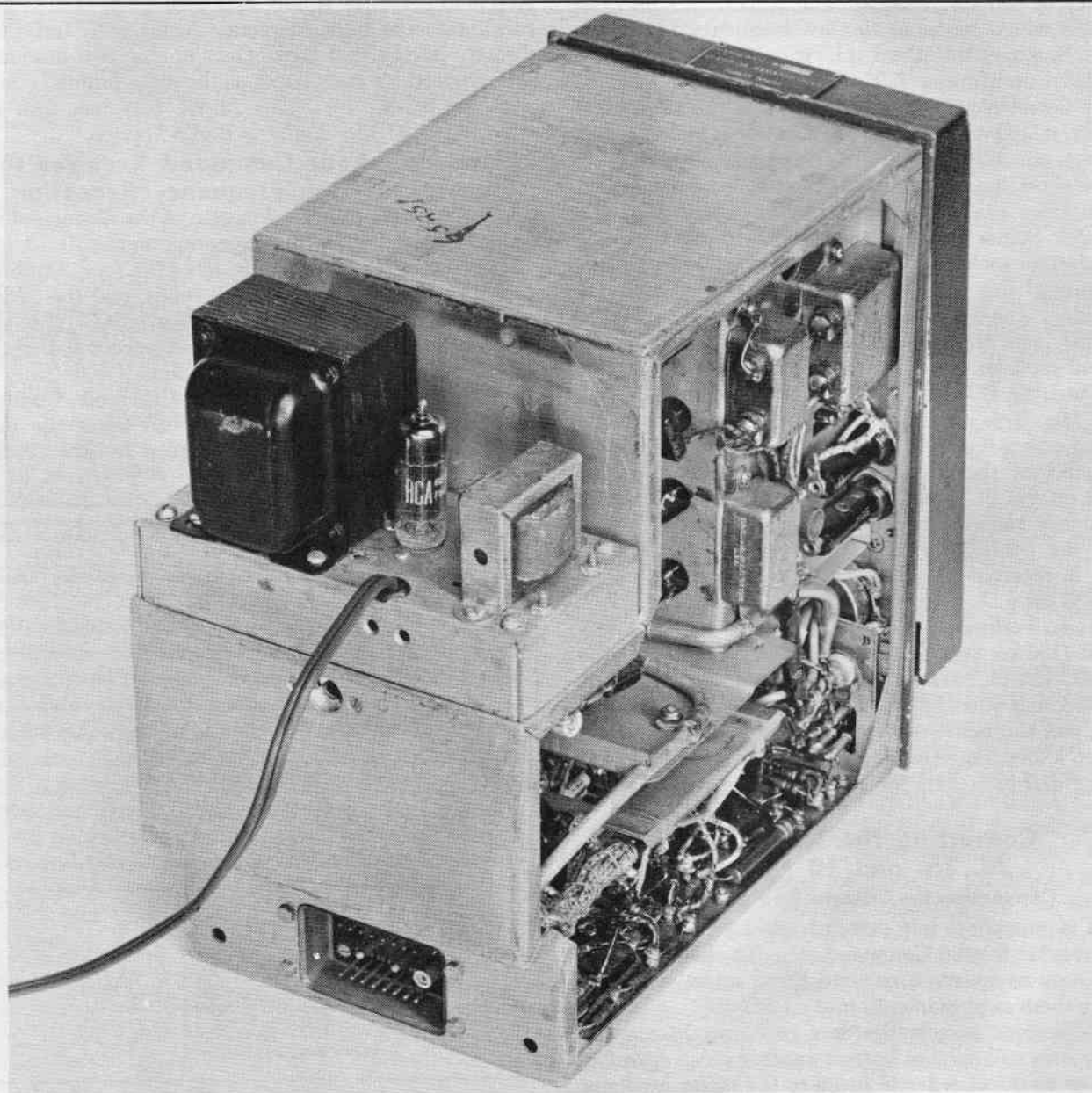


Figure 15

BC-603 F.M. RECEIVER MAKES HANDY 10-11-15 METER A.M./F.M. RECEIVER. A.c. power supply is shown mounted in dynamotor well of receiver.

this base and discard them all, except the 18-pin "Jones" connector. Clean all lugs on this connector and open the eyelets. Jumper pins #3, 6, 9, 12, 15, and 18, as shown in figure 17. Also jumper pins 16 and 17. Finally, jumper pins #1 and 2, and attach a three-inch length of hook-up wire to pin #1. This lead is grounded. Mount the new power transformer at the end of the chassis opposite the connector as shown in figure 15. Mount the 6X4 tube socket near the power connector and place the filter choke above the connector. Wire as shown in figure 17. Be sure the filament windings of the power transformer are phased properly to provide about 11.8 volts. Place the power supply atop the receiver, and you are ready for a.c. operation of the BC-603.

Converting the BC-603 to A.M. Reception

The BC-603 was designed for f.m. reception only. However, some farsighted designer included an audio choke in the cathode circuit of the 6AC7 limiter (V-6). It was probably incorporated to facilitate sweep-alignment of the r.f. and i.f. circuits. In any event, this choke (L-1) permits the limiter also to act as an infinite impedance detector for a.m. signals, and an audio signal appears across this choke when an a.m. signal is tuned in on the receiver. The problem, then, is to switch the audio circuit of the BC-603 between the f.m. detector and this choke. This conversion uses the "intercom" switch (D-2) as an a.m./f.m. switch.

Remove the front panel of the receiver by taking out the four screws at each corner of the cast iron panel guard. The front panel controls will separate from the chassis, being interconnected by J-3 and PG-3. Locate the "intercom" switch (stamped D-2 on the back) and remove the wire between D-2 and J-2. Also remove the wire running from D-2 to the resistors R-22, R-32, and R-33. (Some of these resistors are omitted from certain receivers. They are used as volume correctors). Now, locate the blue-green wire that runs from the audio output transformer T-1 to resistors R-22, R-32, and R-33. Unsolder this wire from the resistors and connect it to the "hot" lug of phone jack J-1. Remove the three resistors.

Next, remove switch D-2 and replace it with a s.p.d.t. toggle switch. Connect three pieces of short shielded wire to the three switch terminals. Mount the switch and ground the shield braids to the panel. On the main chassis, locate C-11, the audio coupling capacitor connected to pin #1 of the audio amplifier tube V-10. One terminal of C-11 is connected to pin #1 of socket V-10, the audio amplifier tube. Leave this terminal of C-11 alone. Unsolder the other terminal of C-11. Connect the shield wire from the switch arm to this terminal of C-11, as shown in figure 18. Connect one of the other shielded wires from the switch arm to the terminal just vacated by capacitor C-11. Connect the remaining shielded lead to pin #5 of socket V-6 (6AC7 limiter). Replace the panel.

10—15 Meter Coverage and Citizens Radio Service (27 Mc.) with the BC-603

It is possible to retune the BC-603 to cover the 10 meter band, as well as 11 meters (the Citizens Radio Service) and 15 meters. This is accomplished by adjusting the capacitors on the left side of the chassis and the tuning slugs on the right side. Presetting the adjustments is an easy way of tuning the receiver to the proper ranges.

Looking at the left side of the set (with the front of the panel toward you) set the red dot on capacitor C-1.7 toward the front panel (6 o'clock). Set the red dot on capacitor C-1.5 to 9 o'clock. Set the red dot on capacitor C-1.3 to 10 o'clock. Finally, set the antenna trimming capacitor C-1.1 to 4 o'clock.

Next open the covers exposing coils LCU-1, LCU-2, and LCU-3. Screw all slugs out counter-clockwise. Screw in the upper slug of LCU-2 three turns, and the lower slug eight turns. Screw in the slug of LCU-1 eleven turns. It should now be possible to receive the full 10-meter band and 27 Mc. Citizens Radio Service at the high end of the tuning dial, and the full 15-meter band at the low end of the dial. Peak up the slugs (except LCU-3) for maximum gain at the low end of the dial. Peak up the capacitors (except C-1.7) for maximum gain at the high end of the dial. Repeat this process a few times until the receiver tracks across the entire range. Finally, adjust oscillator slug LCU-3 and oscillator padding capacitor C-1.7 for full coverage of the amateur bands at each end of the dial. This completes the conversion.

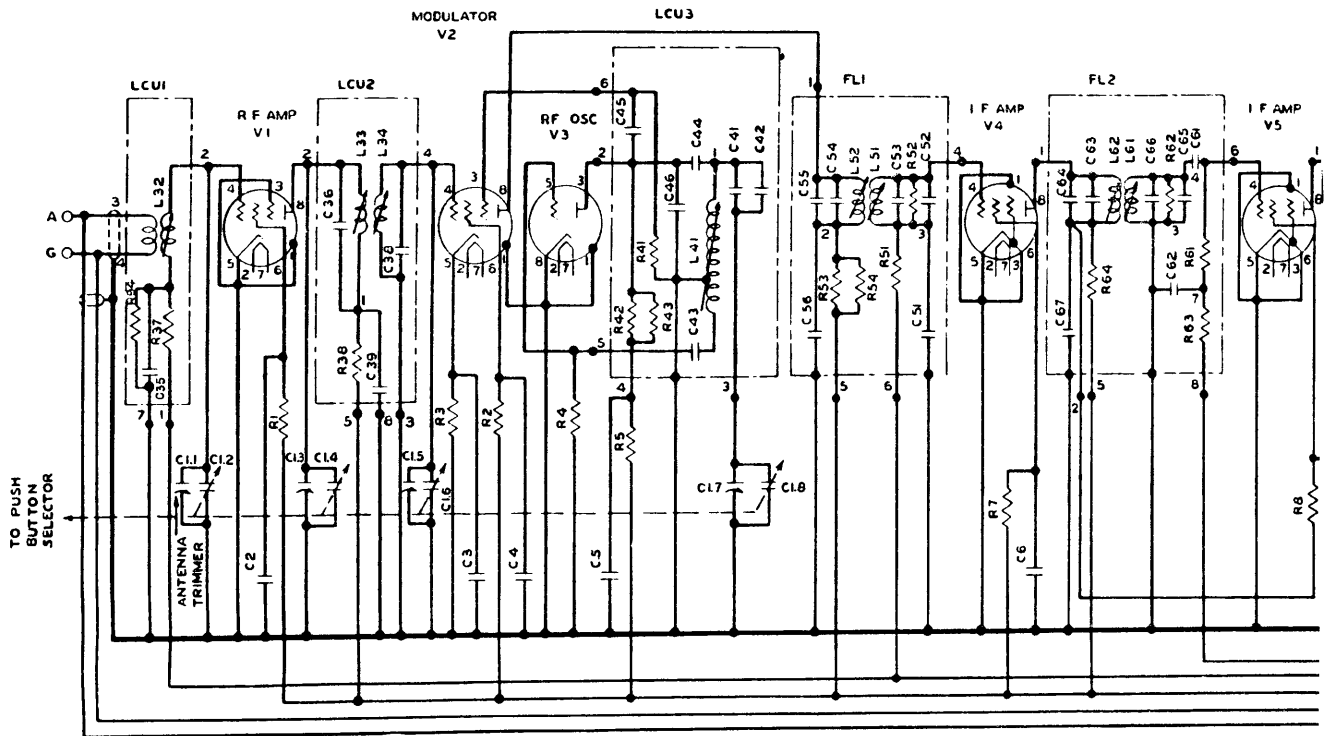
Using the AN/APN-1 Transmitter Section for 420 Mc.

The APN-1 radio altimeter is widely available in surplus stores. Usually the frequency modulator (Y-101) is removed for use in television sweep generators. The rest of the unit can often be bought for a very few dollars. The transmitter section is usable on the 420 Mc. amateur band for short-range work. The actual operating range depends upon the gain of the antenna system, rather than the power of the transmitter, however!

Remove the transmitter from the APN-1 (figure 19). The transmitter will be converted for six-volt filament operation, and a power supply and modulator will be constructed. Remove the modulator (Y-101) from the transmitter if it is still in place.

The first step is to locate the filament wire running between L-105 and L-106. Clip this wire near the end of L-105. Ground the end of the wire emerging from L-105 to the chassis of the transmitter. Connect the free end of the wire emerging from the end of L-106 to the center terminal of the filament feed-through capacitor C-111. The filaments are now wired in parallel for six-volt operation. Next, remove link coil L-107 and the associated coaxial line.

The circuit of the power supply-modulator unit is shown in figure 20. It can be built upon one end of



APPARATUS LEGEND

CAPACITORS

C1.1	16 UUF MAX.
C1.3	16 UUF MAX.
C1.5	16 UUF MAX.
C1.7	16 UUF MAX.
C1.2	62 UUF MAX.
C1.4	62 UUF MAX.
C1.6	62 UUF MAX.
C1.8	62 UUF MAX.
C2	0.006 UF 300V
C3	0.006 UF 300V
C4	0.006 UF 300V
C5	0.006 UF 300V
C6	0.006 UF 300V
C7	0.006 UF 300V
C8	500 UUF 500V
C9	0.006 UF 300V
C10	0.75 UUF 500V
C11	0.006 UF 300V
C12	0.01 UF 300V
C13	500 UUF 500V
C14	0.006 UF 300V
C15	0.5 UF 600V
C16	2 UF 600V
C17	0.01 UF 300V
C18	0.01 UF 300V
C19	0.002 UF 500V
C20.1	0.1 UF 600V
C20.2	0.1 UF 600V
C20.3	0.1 UF 600V
C21	0.01 UF 300V
C22	0.005 UF 300V
C23	40 UF 25V
C24	1 UF 600V
C25	2 UF 600V
C26	0.0005 UF 500V
C35	0.006 UF 300V
C36	10 UUF 500V
C38	10 UUF 500V
C39	0.006 UF 300V
C41	700 UUF 500V
C42	200 UUF 500V
C43	100 UUF 500V
C44	30 UUF 500V
C45	100 UUF 500V
C46	20 UUF 500V
C51	0.006 UF 300V
C52	10 UUF OR 60 UUF 500V
C53	50 UUF SEE NOTE 2

SWITCHES

D1	REC ON-OFF
D2	RADIO-INT
D3	ON-OFF SPEAKER
D4	ON-OFF SQUELCH
D5	TUNE-OPERATE

E1 CALL SIGNAL

F1 FUSE 15 AMP

JACKS

J1	PHONES
J2	PHONES
J3	FRONT PANEL JACK

COILS

L1	LIMITER CATHODE CHOKE
L32	ANTENNA COUPLING
L33	R F PLATE
L34	MOD GRID
L41	R F OSCILLATOR
L51	1ST IF GRID
L52	MODULATOR PLATE
L61	2ND IF GRID
L62	1ST IF PLATE
L71	LIMITER GRID
L72	2ND IF PLATE
L81	DETECTOR INPUT
L82	LIMITER PLATE
L91	IF OSCILLATOR
LS1	LOUD SPEAKER

POTENTIOMETERS

P1	100,000 Ω
P2	200 Ω

PLUGS

P61	RECEIVER PLUG
P62	DYNAMOTOR PLUG
P63	FRONT PANEL PLUG

RESISTORS

R1	30,000 Ω 1W
R2	250,000 Ω 1/2W
R3	500 Ω 1/2W
R4	50,000 Ω 1/2W
R5	300 Ω 1/2W
R6	100,000 Ω 1/2W
R7	30,000 Ω 1/2W
R8	70,000 Ω 1/2W
R9	1,000 Ω 1/2W
R10	250,000 Ω 1/2W
R11	1,000,000 Ω 1/2W
R12	2,000 Ω 1/2W
R13	10,000 Ω 1/2W
R14	250,000 Ω 1/2W
R15	1,000,000 Ω 1/2W
R16	1,000,000 Ω 1/2W
R17	250,000 Ω 1/2W
R18	100,000 Ω 1/2W
R19	2,000,000 Ω 1/2W
R20	300 Ω 1W
R21	30,000 Ω 2W

R22	30,000 Ω 1/2W
R23	5,000 Ω 1/2W
R24	50 Ω 1/2W
R25	2,500 Ω 1/2W
R26	1,200 Ω 1/2W
R27	2,500 Ω 1/2W
R28	2,500 Ω 1/2W
R29	13,000 Ω 2W
R30	5 Ω 4W
R31	6,800 Ω 1W
R32	30,000 Ω 1/2W
R33	30,000 Ω 1/2W
R37	250,000 Ω 1/2W
R38	1,000 Ω 1/2W
R41	100,000 Ω 1/2W
R42	30,000 Ω 1W
R43	30,000 Ω 1W
R51	250,000 Ω 1/2W
R52	30,000 Ω 1/2W
R53	100,000 Ω 1/2W
R54	100,000 Ω 1/2W
R61	100,000 Ω 1/2W
R62	43,000 Ω 1/2W
R63	10,000 Ω 1/2W
R64	1,000 Ω 1/2W
R71	250,000 Ω 1/2W
R72	30,000 Ω 1/2W
R73	10,000 Ω 1/2W
R74	1,000 Ω 1/2W
R81	70,000 Ω 1/2W
R82	250,000 Ω 1/2W
R83	70,000 Ω 1/2W
R84	250,000 Ω 1/2W
R85	1,000 Ω 1/2W
R91	100,000 Ω 1/2W
R92	40,000 Ω 1/2W
R93	2,000,000 Ω 1/2W
R94	15,000 Ω 1/2W
R95	30,000 Ω 1/2W
R96	30,000 Ω 1/2W

T1 OUTPUT TRANSFORMER

V1	VT-112 (6AC7)
V2	VT-112 (6AC7)
V3	VT-94 (6J5)
V4	VT-209 (12SG7)
V5	VT-209 (12SG7)
V6	VT-112 (6AC7)

V7	VT-90 (6H6)
V8	VT-107-A (6V6GT)
V9	VT-229 (6SL7GT)
V10	VT-229 (6SL7GT)

DYNAMOTORS

DM-36-D 12 VOLT

CAPACITORS

C701	0.003 UF 1000 V
C702	0.003 UF 1000 V
C703	0.003 UF 500 V
C704	0.003 UF 500 V
C705	0.003 UF 1000 V
C706	0.003 UF 1000 V

COILS

L701	HV FILTER
L702	LV FILTER
L703	HV FILTER
L704	HV FILTER

J701 DYNAMOTOR JACK

MG7QL 12V DYNAMOTOR

DM-36-D 24 VOLT

CAPACITORS

C801	0.003 UF 1000 V
C802	0.003 UF 1000 V
C803	0.003 UF 500 V
C804	0.003 UF 500 V
C805	0.003 UF 1000 V
C806	0.003 UF 1000 V

COILS

L801	HV FILTER
L802	LV FILTER
L803	HV FILTER
L804	HV FILTER

J801 DYNAMOTOR JACK

MG801 24V DYNAMOTOR

Figure 16
SCHEMATIC, BC-603 RECEIVER.

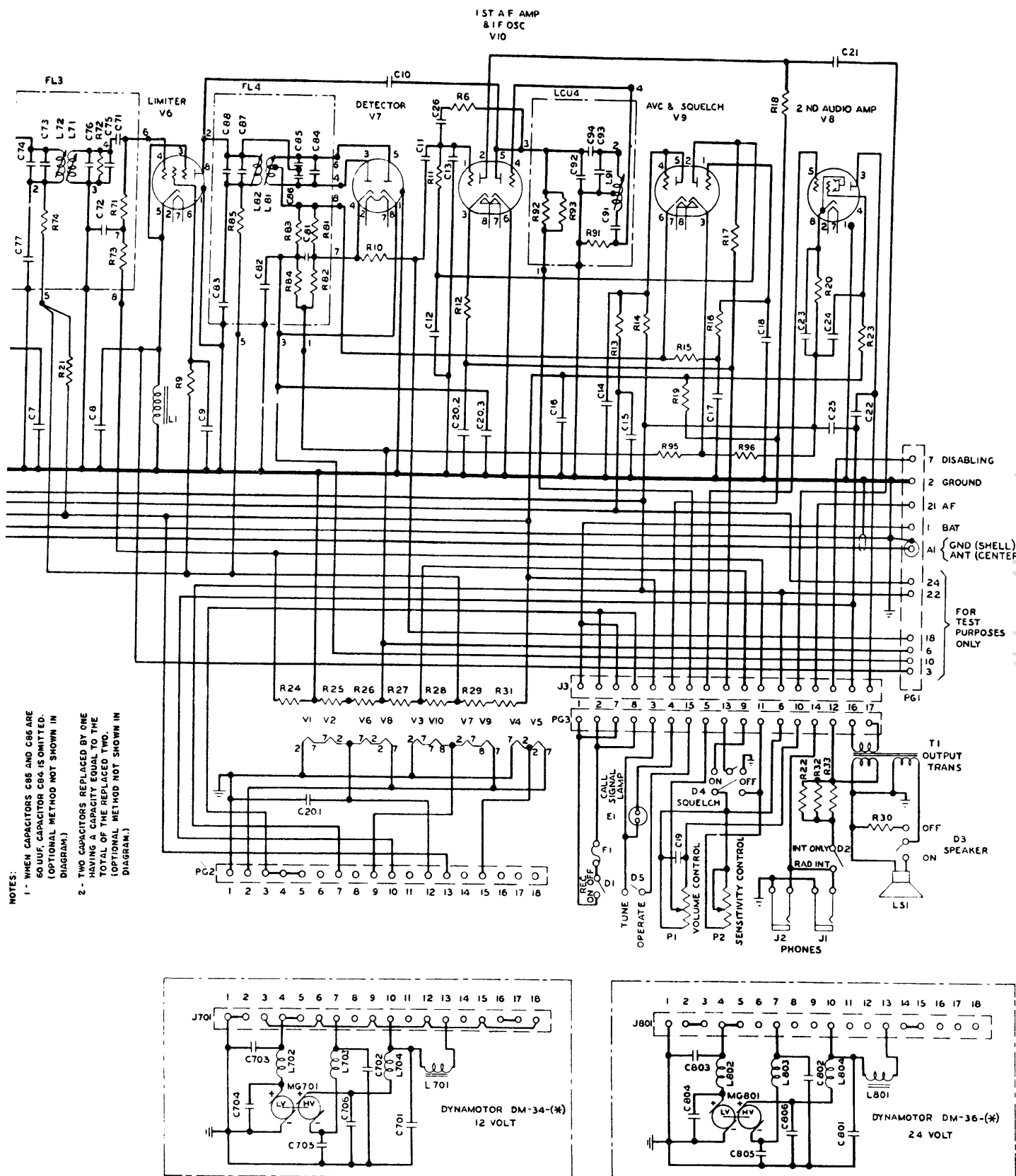


Figure 16
SCHEMATIC, BC-603 RECEIVER

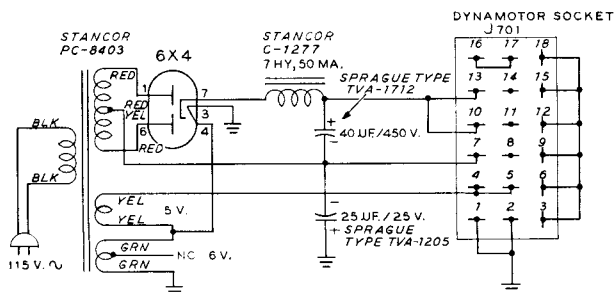


Figure 17

SCHEMATIC, A.C. POWER SUPPLY FOR BC-603. Power transformer delivers 250-0-250 volts at 70 ma., 5 volts at 2 amperes, and 6.3 volts at 2.5 amperes.

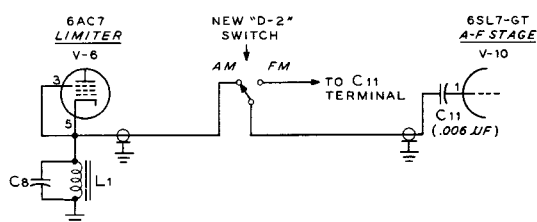
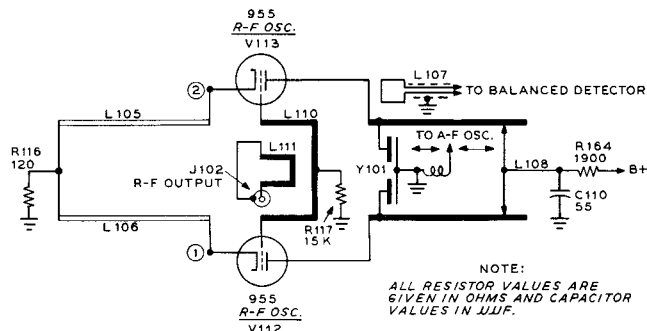


Figure 18

MODIFICATION OF BC-603 FOR A.M./F.M. RECEPTION.

a 8"x10"x2" aluminum chassis. The APN-1 oscillator unit is bolted to the opposite end of the chassis.

Adjustment of the sliding bar on L-108 will tune the oscillator between 425 Mc. and 440 Mc. The spacing between L-111 and L-110 will determine the antenna loading. A 6.3 volt, 150 ma. pilot lamp (brown bead) mounted in a coaxial plug will serve as a dum-



audio amplifier for reception and transmission. The 3Q4 is employed as an audio power amplifier for reception and as a modulator for transmission.

One 3A5 section is used as a crystal oscillator on 17.573 Mc., with the second section acting as a frequency doubler to 35.146 Mc. A second 3A5 is used as a dual doubler, the first section doubling to 70.292 Mc., and the second section doubling to 140.58 Mc. Transmitter output is on this frequency.

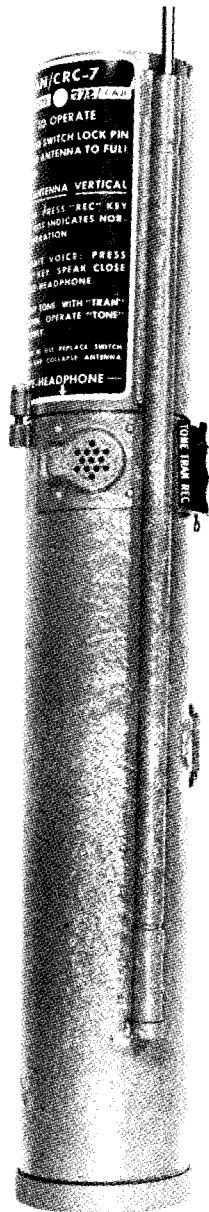


Figure 22

The AN CRC-7 is a battery-operated receiver easily converted for 2-meter amateur operation.

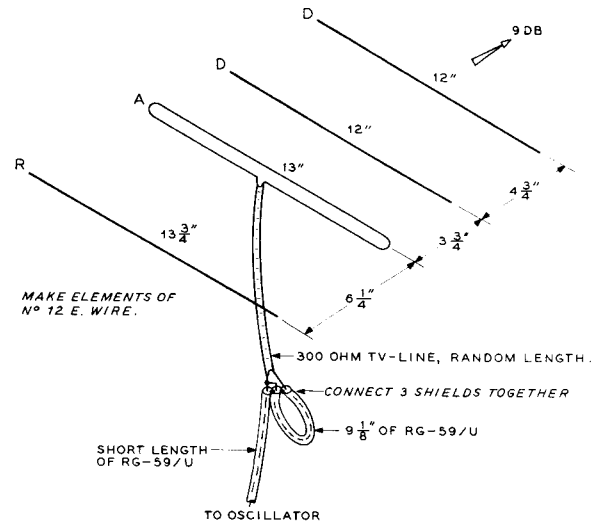


Figure 21
FOUR-ELEMENT BEAM ANTENNA
FOR 420 MC.

Opening the Case A good, sharp hack-saw is an asset in opening the CRC-7 case. The unit is completely hermetically sealed against moisture. Since the batteries are not available, the first step is to cut off the battery compartment. Measure along the side of the unit to the end of the brass butt plate. This will be 8 5/8". Measure your unit to cut just below this brass plate. Do not cut too far into the interior of the battery compartment or you will saw off the battery pins. Remove and discard the shell. Incidentally, the antenna should be fully extended to avoid sawing it off during the cutting operation.

Next, remove the two screws that appear to hold the two halves of the unit together. Mark a line 1/2-inch

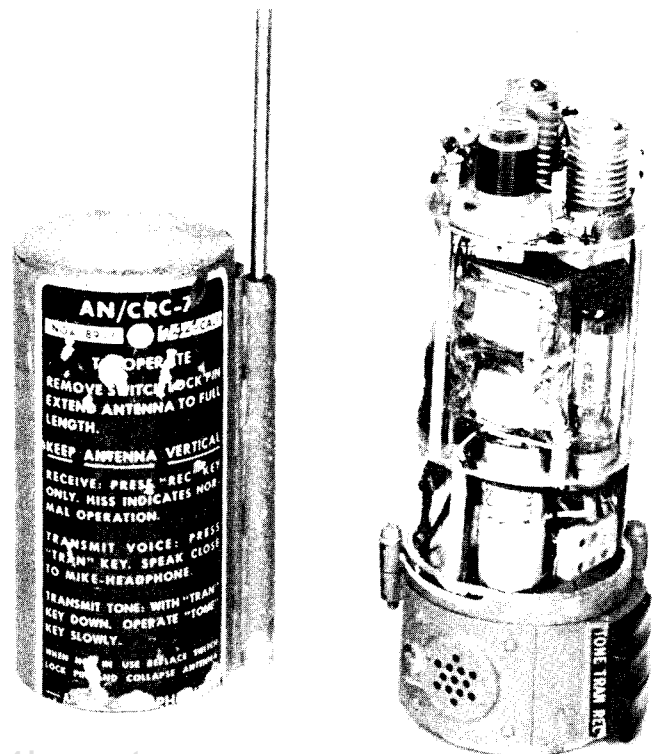


Figure 23

"EXPLODED" VIEW OF AN CRC-7

The battery box is cut off, and the top section is cut open as shown. Cut top section 1/2-inch above push buttons, being careful not to cut too deeply into the case.

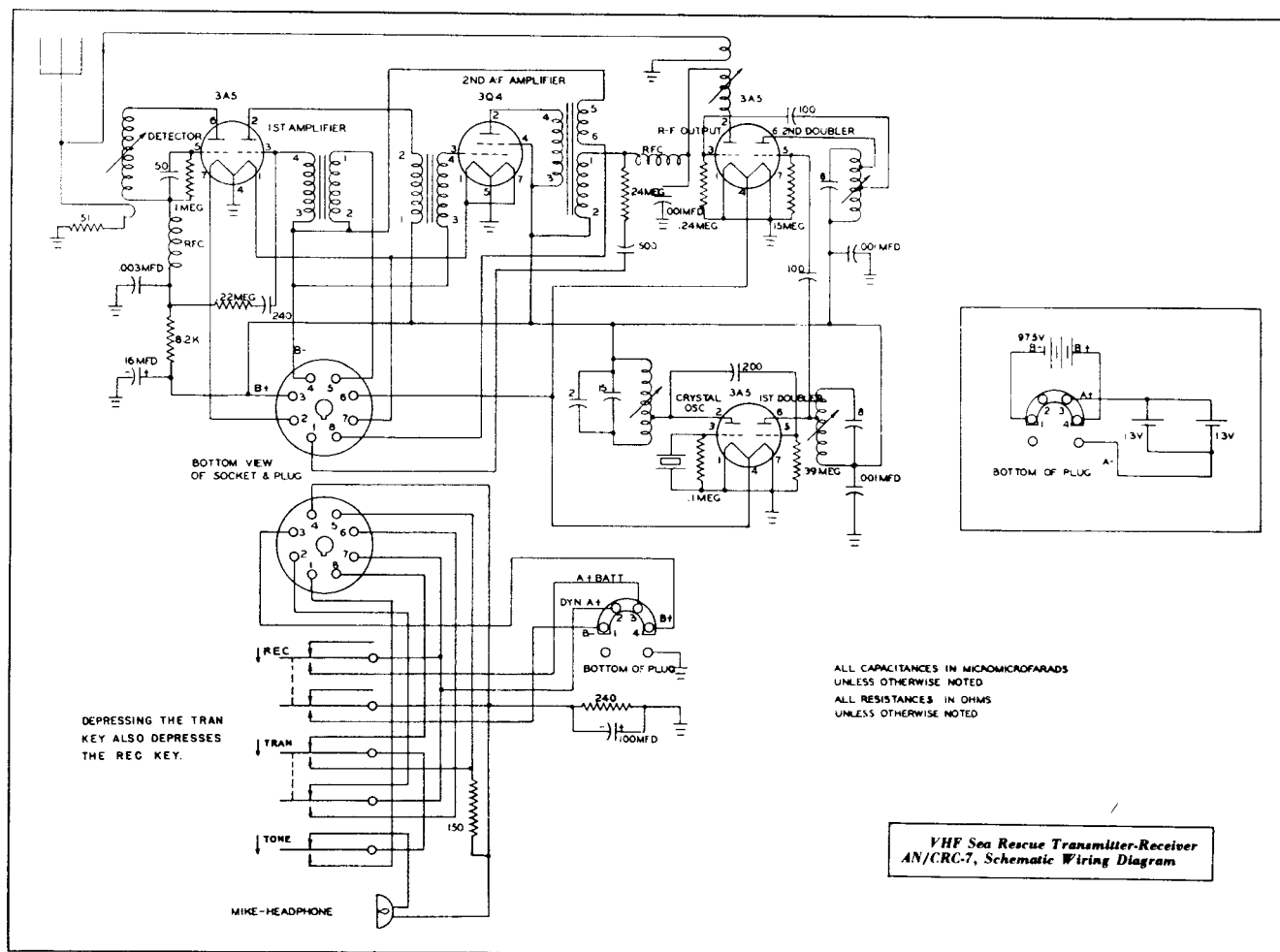


Figure 24
SCHEMATIC, AN/CRC-7 V.H.F. TRANSMITTER-RECEIVER

above the push buttons, and scribe this line all the way around the cannister. Saw along this line, being careful not to cut into the interior of the case, particularly near the screw mounts. Just beneath this area are the audio transformer and r.f. choke, so take care!

Now, you can slide off the cannister. It may take a little jiggling, but use only moderate pressure. Remove the insulating tape to reveal the components of the set. To make sure that no damage has been done during the sawing process, connect a set of batteries as shown in figure 24. Press the "receive" button and you should immediately hear a hissing noise in the earphone unit.

144 Mc. Operation of the Transmitter The transmitter should be adjusted for 144 Mc. operation. All of the coil slugs are silver-plated and raise the resonant frequency of the tuned circuits as they are screwed clockwise into the coil. Since it is necessary to raise the frequency of the transmitter for 144 Mc. operation, it will be necessary to turn all slugs clockwise. This is fortunate, as the slugs are usually sealed with "glyptal" cement, and turning

the slugs counter-clockwise will usually "freeze" them in the cement.

The first step is to remove the transmitter crystal, which is held underneath the 17 Mc. coil form (the one having the most turns). Unscrew the coil bolts from the under-side of the chassis and remove the coil and the crystal. Handle the crystal with care. It is possible to mount a crystal holder on the outside of the case, grounding one lug of the holder to the case, and connecting a small piece of spring brass to pin #3 of the 3A5 oscillator tube socket. Then, when the case is slipped on, the spring brass will contact the ungrounded pin of the crystal socket. A second brass spring is soldered to the chassis deck to make ground connection to the case for the return lead. Crystals in the 18 Mc. range are used for 2-meter work.

A less expensive conversion is to make use of the crystal used in the original equipment. Take a piece of flat glass and put a few drops of water and a little tooth powder on it. Place the crystal blank on the glass and press it lightly but evenly, taking ten or 15 circular "swipes" across the glass plate. Clean the

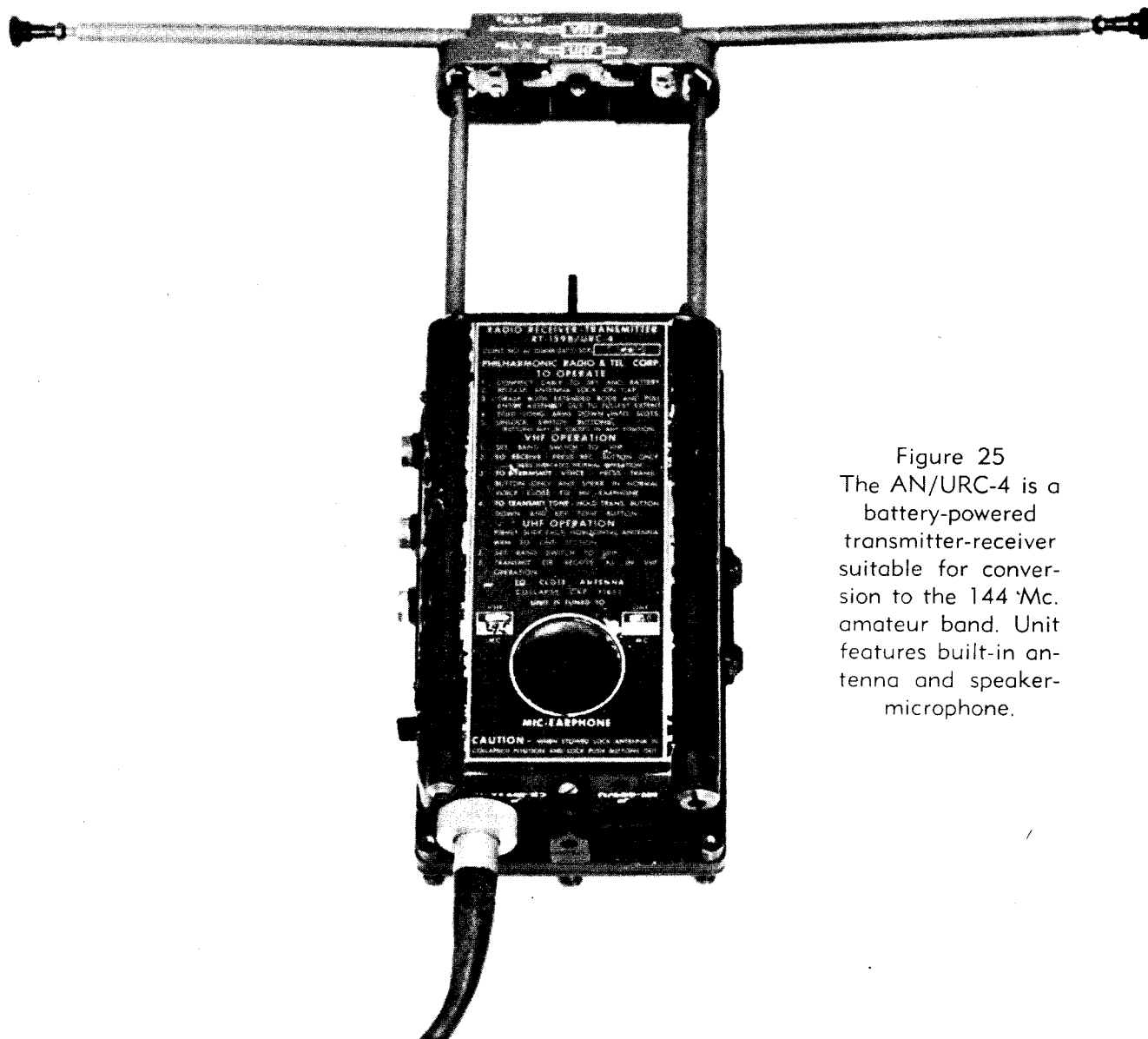


Figure 25
The AN/URC-4 is a battery-powered transmitter-receiver suitable for conversion to the 144 Mc. amateur band. Unit features built-in antenna and speaker-microphone.

crystal with carbon tetrachloride (Caution! Do not breathe the fumes!), replace it in the holder and check the frequency. It will probably be necessary to repeat this procedure several times (retuning the crystal oscillator coil each time) until the harmonic of the crystal falls at the desired spot in the 144 Mc. band.

Next, cut holes at appropriate spots in the top of the cannister to gain access to the tuning slugs when the cover is replaced. It is necessary to tune the transmitter in this manner, since the cannister causes a considerable amount of detuning when it is removed. Peak the slugs of the four coils for maximum signal strength in a nearby receiver, with the antenna whip of the unit fully extended. This completes the transmitter modifications.

144 Mc. Operation of the Receiver

The receiver section of the CRC-7 only requires retuning for 2 meter operation. Screwing the slug into the detector coil about three turns will hit the band. Some receivers will not tune above 147 Mc. and it will be necessary to remove one turn from the detector coil to tune up to 148 Mc. If desired, the receiver slug can be removed and a $\frac{1}{4}$ -inch extension shaft soldered to it. By slotting the side of the case, you can tune the receiver manually by means of a knob placed on the shaft. The sensitivity of the receiver is such that a signal of less than 3 microvolts can easily be heard and copied.

The CRC-7 requires two flashlight batteries parallel-connected for the filament supply (1.4 volts), and two 45 volt B-batteries series-connected for the B-plus

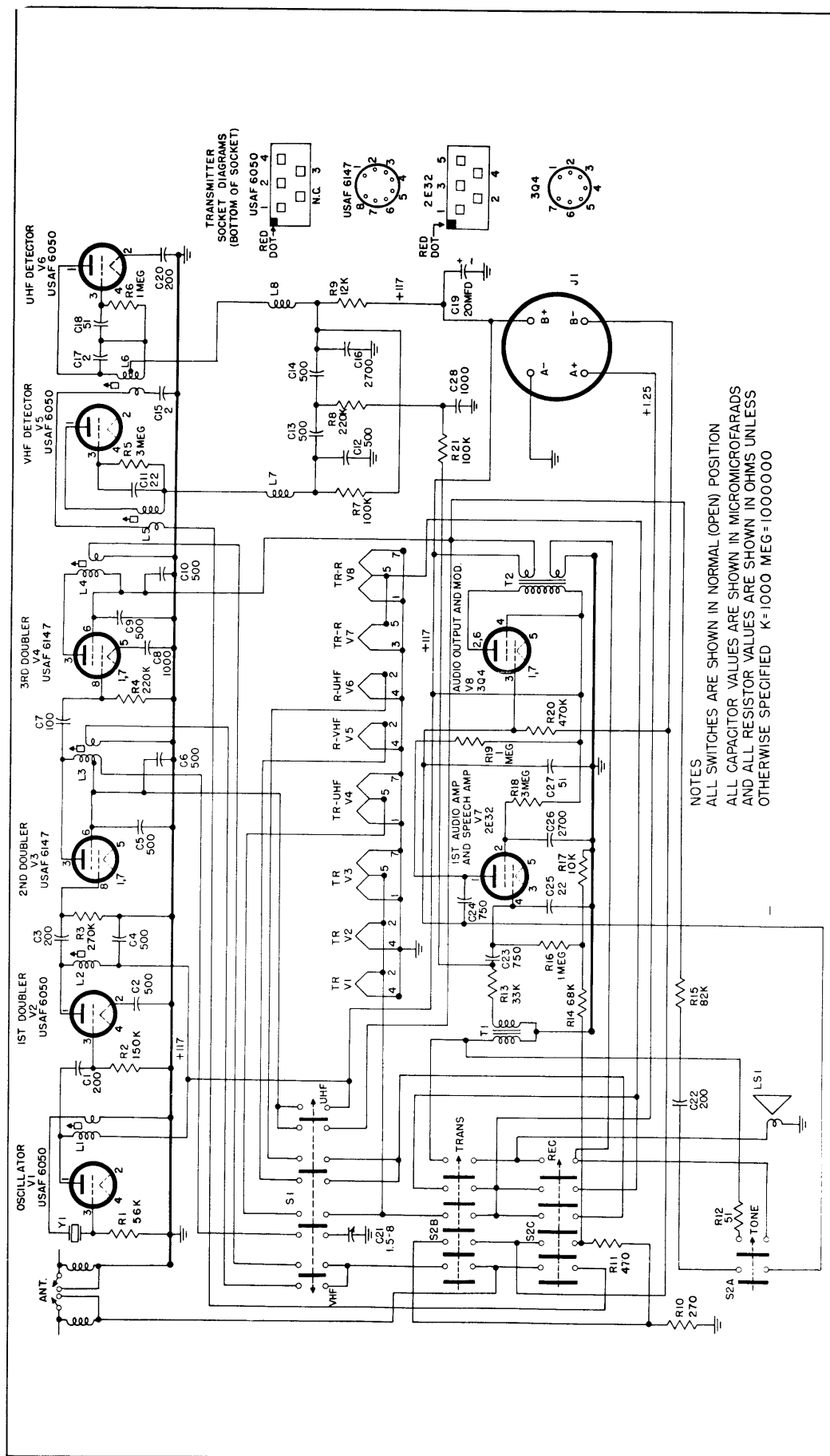


Figure 26-A
SCHEMATIC, AN/JRC-4 TRANSMITTER-RECEIVER FOR RT-159 UNIT

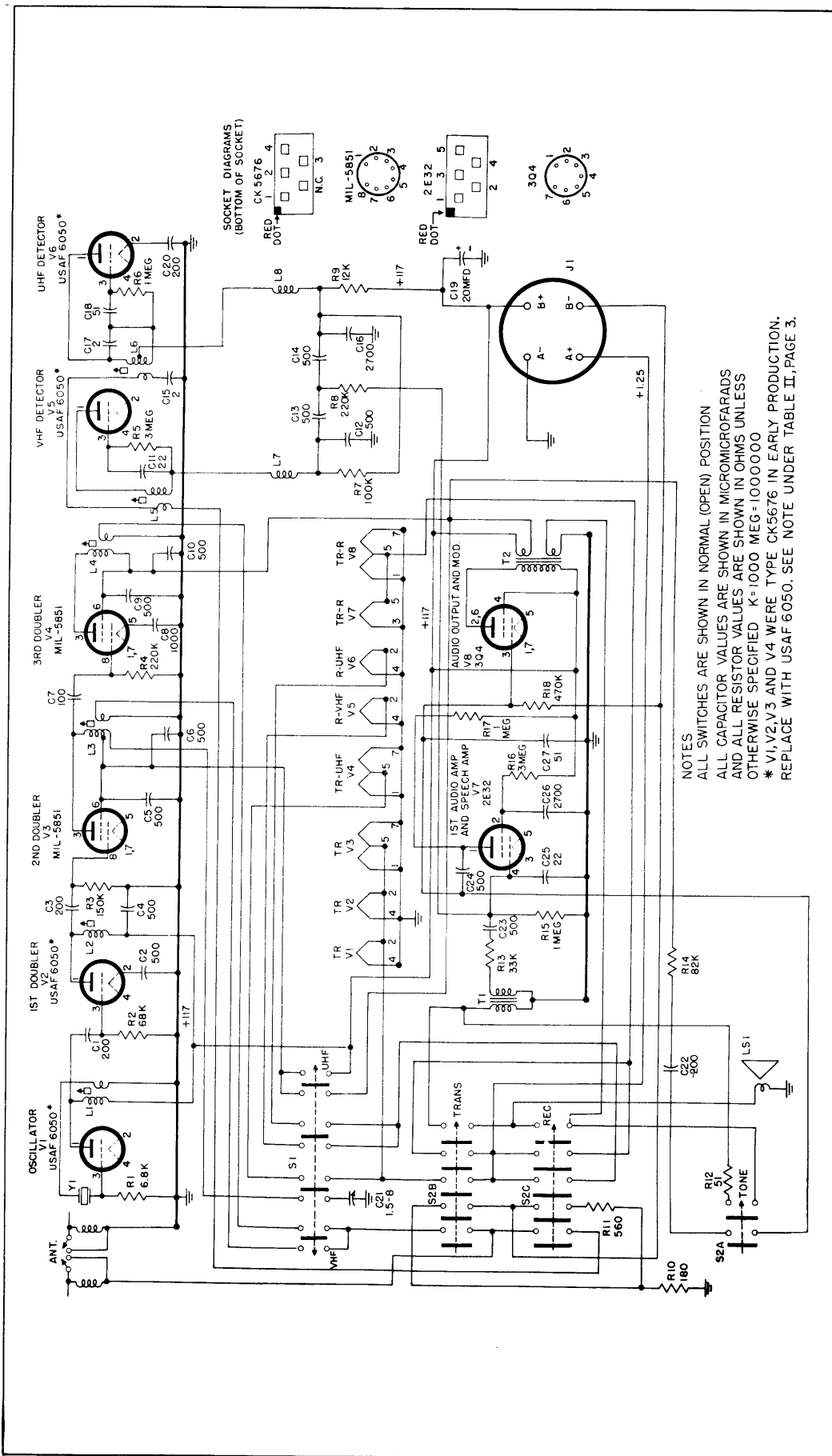


Figure 26-B
SCHEMATIC, AN/URC-4 TRANSMITTER-RECEIVER FOR RT-159A UNIT

supply. The RCA battery pack VS-064 will work well with this unit.

Using a converted CRC-7 with the self-contained antenna, contacts up to 30 miles distance have been made.

Converting the AN/URC-4 to a 2 Meter Handie-Talkie

The AN/URC-4 is a battery powered transmitter-receiver intended for Air-Sea rescue service like its predecessor, the CRC-7. Unlike the CRC-7, the URC-4 employs more "exotic" circuits, components and smaller construction. In addition, it is designed to operate on two frequencies: 121.5 Mc. and 243 Mc. To convert the URC-4 to 144 Mc. it is necessary to re-wind a few coils, purchase a new crystal, and connect

a set of batteries. The unconverted URC-4 is shown in figures 25 and 27.

The URC-4 employs eight tubes, all of which are sub-miniature with the exception of the audio output tube. A dual frequency antenna folds completely into the case. Telescoping the antenna automatically shorts out the v.h.f. antenna loading coils and converts the antenna to u.h.f. use at 243 Mc. For a two meter conversion, the u.h.f. circuitry and tubes are not used.

A complete circuit of the URC-4 is shown in figures 26A and 26B. Two separate detectors are used, one for v.h.f. and one for u.h.f. Each super-regenerative detector employs a type 6050 miniature high- μ triode. (Note: Some early models use 5676 tubes). Bandswitch S-1 lights the filament of the tube in use. The detector audio output circuit is novel in that it incorporates a "bridge-T" filter tuned to the quench frequency of super-regeneration. A variable quench control is thus not required and improved audio response is realized. The v.h.f. detector (V-5) tunes only to 144 Mc. and must be modified for 2-meter work.

The transmitter section employs a CR-24/U crystal at 10.12 Mc., ground for third-overtone operation with a 6050 oscillator (V-1) operating at 30.375 Mc. This tube drives a second 6050 doubling to 60.75 Mc. A beam-power pentode (type 5851) is used as a doubler to 121.5 Mc. For v.h.f. operation, signals are link-coupled out of the plate circuit of this stage. A second 5851 acts as a doubler to 243 Mc. for u.h.f. service and is activated by the u.h.f./v.h.f. switch, S-1. This last tube may be removed and kept as a spare.

The audio section consists of a 2E32 speech amplifier driving a 3Q4 power amplifier (reception). During transmission, the 3Q4 serves as a modulator. A feedback circuit is incorporated in the audio system for modulated tone transmission, operated by switch S-2A.

The Two Meter Conversion

It is a good idea to establish first that the URC-4 is in working order on 121.5 Mc. when you receive it. The original battery pack is unobtainable, but a good substitute is the RCA VS-064 pack (1.4 volts, and 90 volts). Battery cables are usually avail-

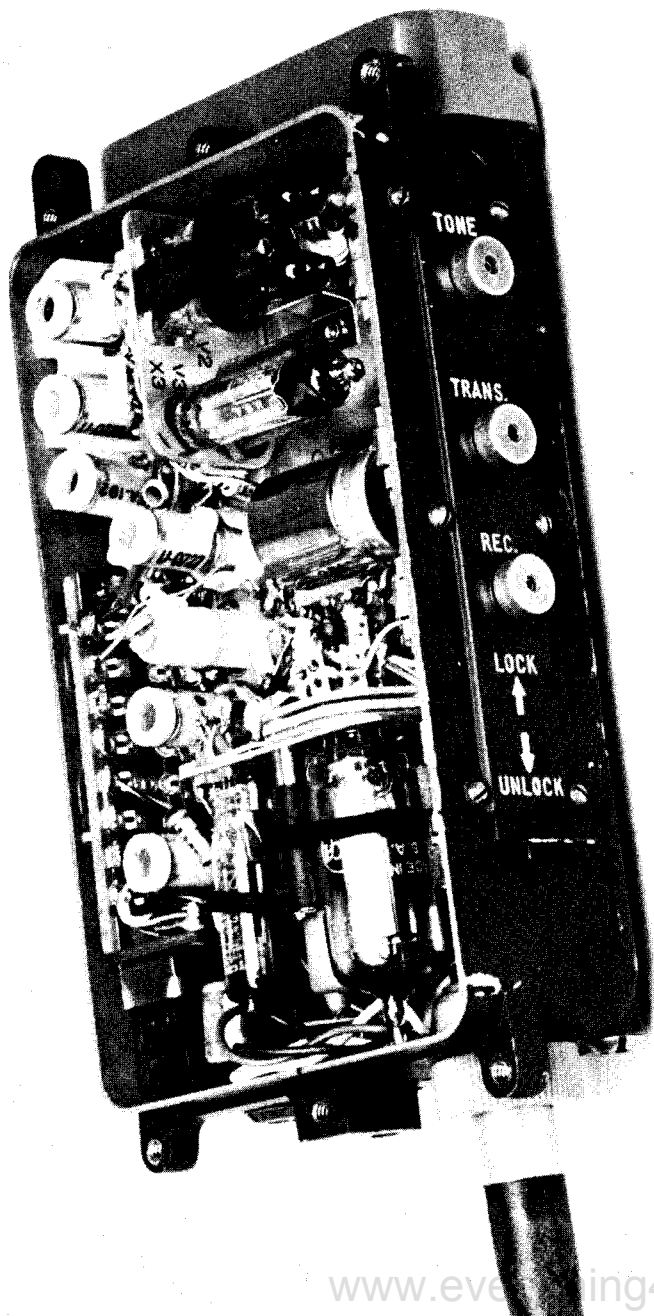


Figure 27

AN/URC-4, WITH COVER REMOVED

At top of cabinet are tubes V-1, V-2, and V-3. Oscillator coil L-1 is behind V-1 and is tuned to 30.375 Mc. Doubler coil L-2 is behind V-2 and is tuned to 60.75 Mc. Doubler coil L-3 is behind V-3 and is tuned to 121.5 Mc. Coil L-4 is behind capacitor C-19 (20 μ fd.) and is tuned to 243 Mc. Tuning capacitor C-21 is next to L-4. Receiver coils L-5 and L-6 are at bottom of case.

Coil L-1 is retuned to 36 Mc., coil L-2 to 72 Mc., coil L-3 to 144 Mc. Tubes V-4 and V-6 (under the chassis) are removed.

able at the surplus store. Connect the battery as indicated in figure 26 to receptacle J-1. Press the receive button and a loud hiss should be heard from the combination microphone-earphone. Press the transmit button and check for r.f. with a field strength meter. *Do not* leave the transmitter operating for more than a few seconds when making this check as the 121.5 Mc. frequency is still used for military communication.

The first step in the conversion is to modify the tuned circuits. Remove the chassis from the case by loosening the chassis mounting screws. Remove the u.h.f. detector (type 6050, V-6) located under the chassis. Save the tube for a spare. Remove the u.h.f. power amplifier tube (type 5851, V-4) and save for a spare. Coil L-3 of the second doubler stage (V-3) will now resonate to 144 Mc. without re-winding.

Next, remove the neoprene waterproof cover over the microphone-earphone grill. This will improve the modulation. Now, locate the end of coil winding L-1 that connects to pin #1 of socket V-1 (6050, oscillator). Unsolder this end of the winding, pull it through the eyelet of the coil form and unwind three turns. After unwinding, feed the wire back through the eyelet and solder to pin #1 of socket V-1, trimming off the excess wire.

The next step is to locate coil winding L-2 that attaches to pin #1 of socket V-2 (6050, doubler). In the same manner as before, disconnect the wire, unwind two turns, and resolder. Coil L-3 is left "as is." Coil L-4 may be removed, as it is no longer used.

A transmitter crystal between 36 and 37 Mc. must be used for 2 meter service. A replacement type CR-24/U crystal is expensive, and a low-cost hermetically sealed type FM-1 crystal is recommended as a substitute. This crystal may be obtained from International Crystal Mfg. Co., 18 North Lee St., Oklahoma City, Oklahoma. The new FM-1 crystal may be secured by lifting the old pressure spring and sliding the new crystal into position. Solder the two wires to the original crystal holder terminals. Make sure the crystal is not free to move about, or dropping the CRC-7 might fracture the crystal. This completes the transmitter modification.

Receiver Modification for 2 Meters Identify the wire running between detector coil L-5 and the transmit-receive switch S-2. Unsolder this wire at the switch, pull back to the coil, and unwind one turn from the coil, leaving 1-1/6 turns on the link. Route the wire back to the switch, slip a piece of "spaghetti" tubing over the wire, and resolder to the original switch terminal. Next, identify the wire running between coil L-5 and pin #1 of detector socket V-5. Disconnect this wire at the socket, and as before, unwind one turn from L-5, and reconnect the wire end to socket V-5. This completes the receiver modification.

Antenna Modification for 2 Meters For 121.5 Mc. operation the dipole antenna system employs two loading coils. For best results on 144 Mc., these coils must be retuned. Unfold the antenna completely to the v.h.f. position. Note that one of the vertical support rods of the antenna structure is grounded to the chassis and the other passes through an insulator into the case. Mark near the appropriate coil (on the cap) the letters "A" (for antenna) and "G" (for ground). Unscrew the vertical rods near the cap with a small wrench. Solder a one-inch loop of wire across the two contacts near the center of the antenna cap. Lift out the two loading coils and remove all but one turn from the coil marked "G". Remove all but two turns from the coil marked "A". Replace the coils.

Now, insert the coil of a grid-dip oscillator into the loop of wire. Make sure the antenna is fully extended and clear of nearby metallic objects. Check the resonant frequency of the antenna, which should be close to 145 Mc. If not, adjust the coil "A" by spreading or compressing the turns which should put the antenna on frequency. Replace the antenna assembly.

Testing the Unit Insert the FM-1 crystal, and connect the batteries. Press the "transmit" button and listen for the carrier in a nearby receiver. If no signal is heard on the proper frequency, slowly unscrew the slug of coil L-1 until the oscillator starts operation. Peak coils L-1, L-2, and L-3 for maximum received signal with the URC-4 antenna fully extended.

To tune-up the receiver, press the "receive" button and adjust the slug of coil L-5 until local two-meter signals are heard. The slug should be almost completely inside the coil form. Placing the cover on the URC-4 will detune the circuits, so holes should be drilled at appropriate places in the cover, and final slug adjustments are made after the cover is in position. Under proper conditions, the unit is capable of transmitting and receiving over distances up to 30 miles or more. The power of the transmitter and sensitivity of the receiver are well matched, and you should be able to work anyone you can hear.

Converting the MD-7/ARC-5 Modulator for Amateur Use

The MD-7 modulator unit is readily available on the surplus market and may be easily converted to a 75-watt modulator for the ARC-5, or other transmitter, running up to 150 watts input. The MD-7 includes two 1625 modulators (12 volt 807's), a VR-150 voltage regulator, and a 12J5 tone modulator for m.c.w. service.

The easiest way to adapt the modulator for general use is to strip the chassis of all components except the tube sockets, the input transformer T-1, and the output transformer, T-2. The modulator should now be rewired according to the diagram of figure 28.¹ The circuit is designed to be used with a surplus

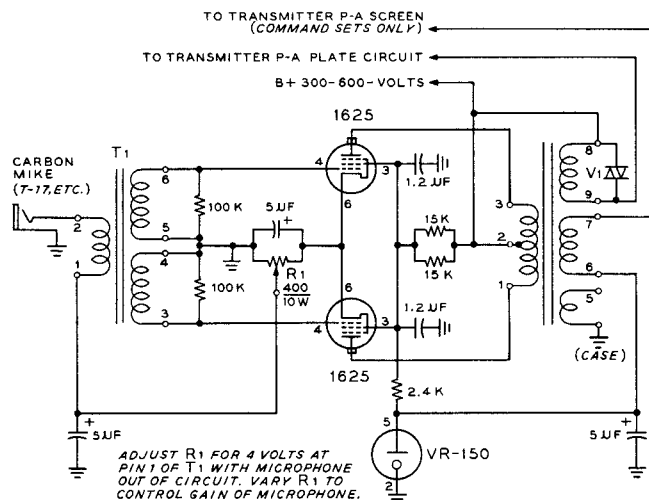


Figure 28
MODIFIED MD-7/ARC-5 UNIT MAKES
MODULATOR FOR AMATEUR USE
T-1 and T-2 are original transformers.

carbon microphone, such as the T-17. Adjust the sliding tap on the cathode resistor to produce six volts as measured across the microphone jack with the microphone removed.

Rectifier V-1 connected across pins #8 and 9 of modulation transformer T-2 is a "varistor" that serves as a protective device for the transformer. It is a round, red unit with black caps, and is mounted beside the two large, black 15K wire wound resistors. Pins #1 and 3 are atop the modulation transformer, T-2. The empty 12J5 socket can be employed as a power socket.

Converting the Command Transmitter Relay for Antenna Change-Over Use

When converting Command transmitters such as the "ARC-5" or "BC" series, the antenna switching relay is usually discarded. This relay may be adapted for either 6- or 12-volt mobile operation.

The relay (identified as K-54 in the ARC-5 units) employs two series-connected coils. The pole pieces pull the armature from both directions, so to speak. The armature in turn moves a spiral-wound silver-plated contact between the antenna and ground posts of the transmitter.

Mount the relay on a small sheet of aluminum, as shown in figure 29. It may be placed on one side of a small chassis-box. Mount the spiral to one SO-239 coaxial receptacle, and permit the contact arm to move between the old contacts which have been soldered to two SO-239 connectors mounted on each side of the movable arm.

As wired, the relay coils are connected in series and work on 24 volts. To use the coils on 6 volts, wire the coils in parallel with the magnetic fields aiding each other. For 12-volt operation, merely connect to one of the coils.

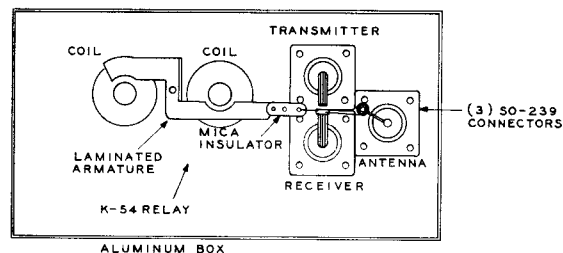


Figure 29
K-54 relay of BC-442 Antenna Control Unit is mounted on aluminum plate. Three coaxial receptacles are used for relay terminals. Coils may be connected for 6, 12, or 24-volts, d.c.

Converting the RM-52 (RM-53) Telephone Unit to a Phone Patch

Two pieces of military telephone equipment readily available on the surplus market are the RM-52 remote control unit, and the RM-53 control unit. Both of these units contain a high quality transformer suitable for phone-patch service. The transformer carries the military part number C-280A, and the manufacturer's part number 83718. The transformer has balanced 600, 150, 250, and 4000 ohm windings, and is well suited for many other devices, such as line matching, isolation, impedance step-up, etc.

The phone-patch is built in a small aluminum case, and wired as shown in figure 30. A simple r.f. filter is placed in series with the telephone line to prevent r.f. feedback. A d.p.d.t. toggle switch is used to disconnect the phone line and return the microphone to normal use. Always disconnect the patch when it is not being used.

To use the patch, turn on the control switch and insert the phone plug in the receiver headphone jack. If your receiver has a 500 ohm output, it can be permanently connected to the 500 ohm terminals. Attach your crystal microphone to the microphone jack, and run a shielded line to your speech amplifier. Attach the phone patch to the telephone line at the base of the phone. Receiver output will now pass over the phone line, and the phone will modulate your transmitter.

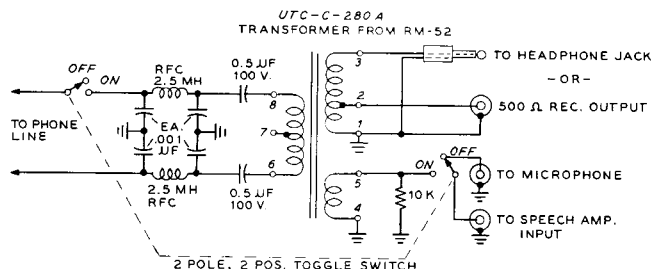


Figure 30
SCHEMATIC, PHONE PATCH MADE
FROM RM-52 TELEPHONE UNIT

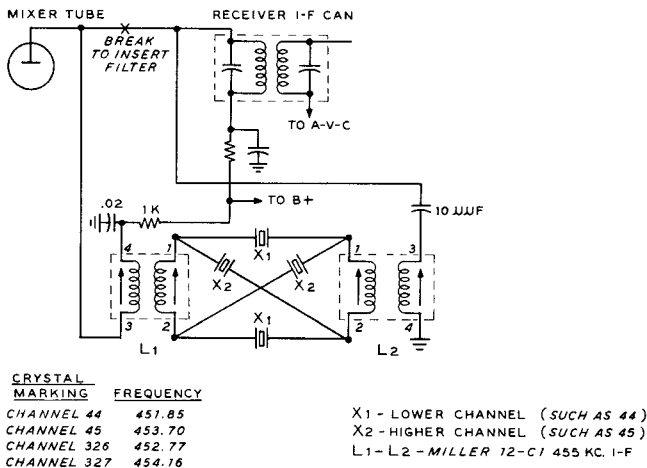


Figure 31
SCHEMATIC, CRYSTAL FILTER FOR
455 KC. I.F. AMPLIFIER

Make a Single Sideband Crystal Filter for Your Receiver with Surplus Crystals!

The type FT-241A crystals (used with the BC-604) are plentiful and cheap on the surplus market. These crystals cover the range of 370 kc. to 500 kc. in 1.85 kc. segments. The crystals are used on their 54th harmonic, and are marked 20.0 Mc. to 27.9 Mc. in 100 kc. jumps. Other crystals in the same range are available that are separated by a frequency difference of 1.39 kc. These crystals are marked 27.0 Mc. to 34.6 Mc. (Channels 270-346).

An efficient crystal filter may be made from four of these surplus crystals. The one stage full-lattice filter is shown in figure 31 and may be used in any receiver having a 455 kc. intermediate frequency amplifier. For everyday use it is not necessary to match crystals. The filter will greatly increase the selectivity of the receiver, reducing the interference level and permitting better reception.

Any two adjacent channels may be used that fall in the i.f. range of the receiver. Channels 44 to 48, and 326 to 330 all fall within the tuning range of standard 455 kc. i.f. transformers.

Building the Filter The layout of the filter is determined by the available space within your receiver. In general, the filter components should be mounted on a small aluminum plate having a small shield across the middle (on both the top and bottom sides) to separate the input and output circuits of the filter. The filter should be located

between the mixer tube and the first i.f. transformer can in the receiver. All interconnecting leads should be kept very short. The lead connecting the mixer tube to the transformer is broken, and the filter is inserted in this circuit as shown in the diagram.

Upon completion, tune a signal generator to the center frequency of the filter. (If channel 44 and 45 crystals are used, tune the signal generator to 452.77 kc. A surplus BC-221 frequency meter will come in handy). Peak filter transformers L-1 and L-2 to this new frequency as well as all the i.f. transformers in the receiver. The insertion loss of the filter is only about 6 decibels, so the addition of an extra tube to boost the gain of the receiver is not required. The filter may be used for s.s.b., a.m.-phone, and c.w. reception.

Converting the T-23/ARC-5 Transmitter to 144 Mc. or 50 Mc.

The T-23/ARC-5 transmitter covers the v.h.f. range of 100-150 Mc. in four channels. It is a companion piece of equipment to the R-28/ARC-5 receiver. Together, these two pieces of equipment make up the v.h.f. portion of the ARC-5 radio set. The equipment is designed to operate from a 24-28 volt d.c. power supply. The T-23 transmitter mounts in a MT-69/ARC-5 rack. Power output of the transmitter is 10 watts into a 50 ohm antenna.

The transmitter channels cover the following frequency ranges:

- Channel A: 100-124 Mc.
- Channel B: 122-146 Mc.
- Channel C: 122-146 Mc.
- Channel D: 132-156 Mc.



Figure 32
THE T-23/ARC-5 V.H.F. TRANSMITTER
Coaxial connectors J-301 and J-302 are at upper left, with connectors J-307 and J-309 at bottom of sloping front panel. R.f. tuning adjustments of amplifier stage may be accomplished through "door" on panel.

The crystal frequency is 1/18 of the carrier frequency in all cases. Front, top, and bottom views of the unconverted transmitter are shown in figures 32, 33, and 35, and the schematic is given in figure 34.

Three of the transmitter channels (B, C, and D) will function on 2 meters without alteration. Channel A is converted to 50 Mc. (six meters). The tube line-up of the transmitter is:

- 1-1625 (V-301) crystal oscillator
- 1-1625 (V-302) first harmonic generator
- 1-832A (V-303) second harmonic generator
- 1-832A (V-304) r.f. amplifier

The power amplifier is plate and screen modulated by the separate MD-7/ARC-5 modulator. This unit is shown fully converted in another section of this Manual.

In order to use the original tubes, a 12-volt filament transformer is included in the power supply unit. The ARC-5 transmitter employs six d.c. relays. These are:

- K-301—Antenna changeover relay
- K-302—Plate and screen voltage control
- K-303—Modulator screen and key control
- K-304—Motor tuning control
- K-305—Auxiliary plate and screen voltage control
- K-306—Modulator plate and voltage regulator interlock

All relays except the antenna changeover unit (K-301) are removed in the conversion. The complete conversion is outlined in steps to ensure that changes are made properly and in the correct sequence. Check off each step as you do it.

- 1—Cut the wires going to the coil of relay K-305. Tape the leads.
- 2—The red/white wire coming from one of the terminals of K-305 is cut, stripped, and soldered to the top terminal of resistor R-315 (300 ohms). This resistor is in the cathode circuit of the 832A amplifier (V-304). The top terminal has two green and white wires attached to it. Leave these wires in position.
- 3—Remove the ground connection from R-315. The resistor now serves only as a tie-point.
- 4—Slip the large, black 15,000 ohm resistor, R-329 (front of chassis near 1625 oscillator socket) out of its bracket. Save the resistor.
- 5—Remove the two wires from the back end (toward the crystal socket) of the bracket. Twist the wires together. They will be attached to a terminal strip in a later operation.
- 6—Remove R-327 (3,600 ohms—orange, blue, red) from the contact terminal of relay K-303 and attach it to the back end of the 15,000 ohm resistor bracket.
- 7—Remove the two leads from the front end of the 15,000 ohm resistor bracket and tie them together. They will be attached to a terminal strip in a later operation.
- 8—Remove the green/white wire from the contact terminal of relay K-303 and attach it to the front end of the 15,000 ohm resistor bracket.
- 9—Replace the 15,000 ohm resistor in the bracket.
- 10—Remove the three relays K-303, K-302, and K-305 from the side of the chassis. Do not remove the wires from the relays.

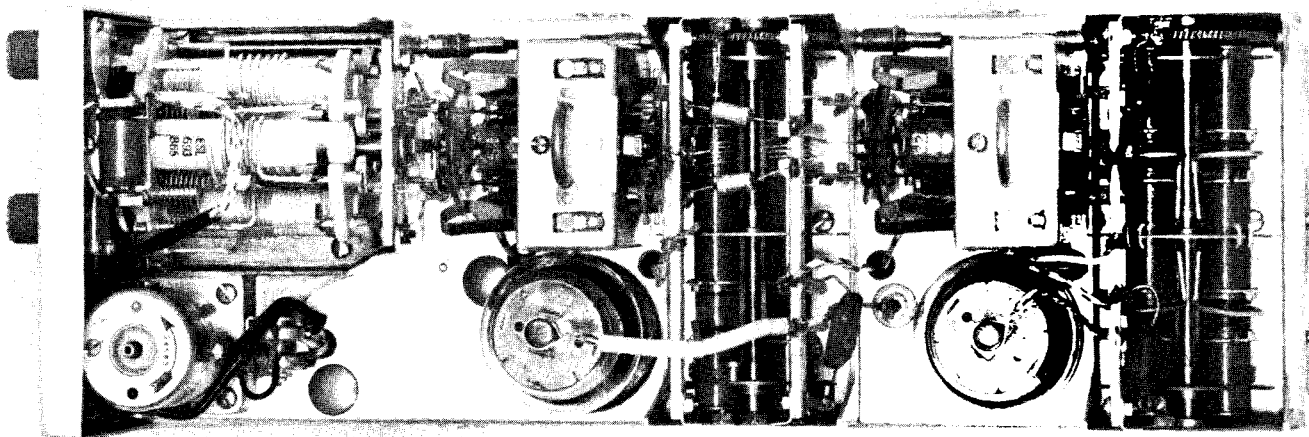


Figure 33
TOP VIEW OF T-23/ARC-5 WITH DUST COVER REMOVED
Amplifier coils are near front panel, next to tuning motor, with 832-A tripler at rear. Oscillator and multiplier tubes are next to 832-A's. Drive shaft for rotary turrets runs along the side of amplifier chassis. Each 832-A stage mounts in removable sub-chassis.

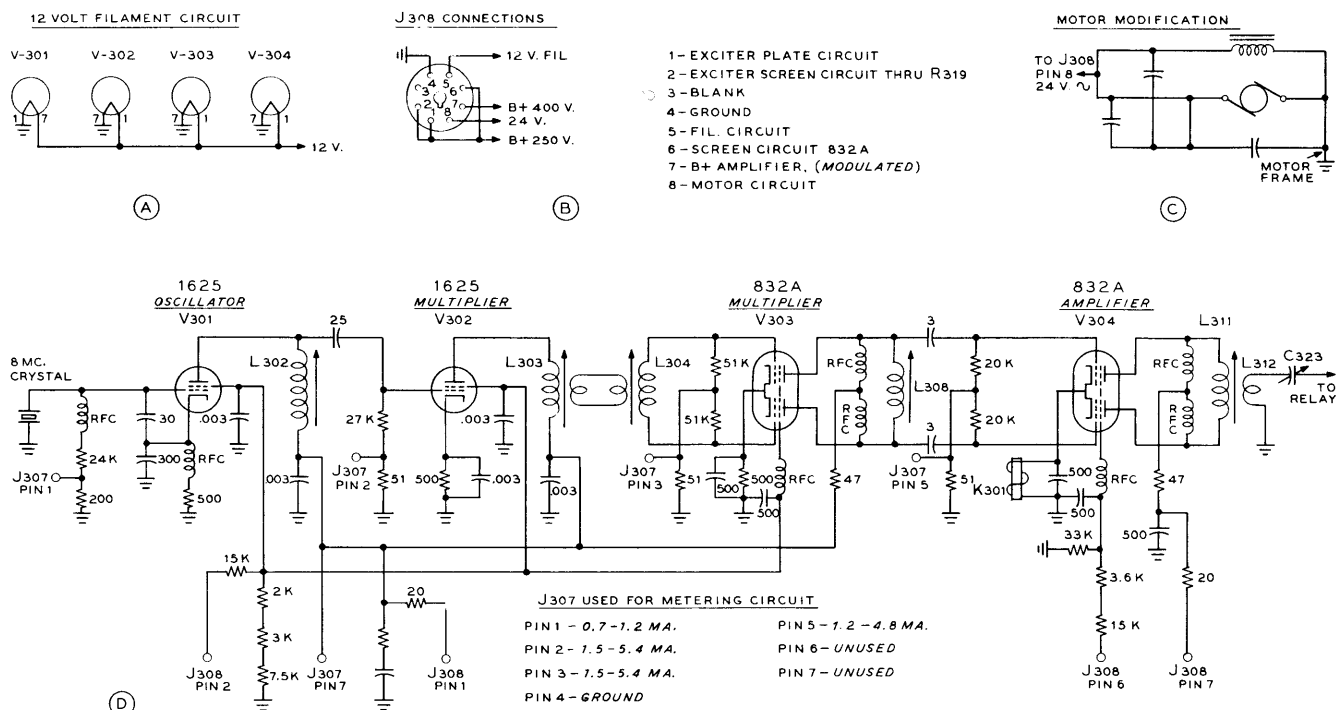
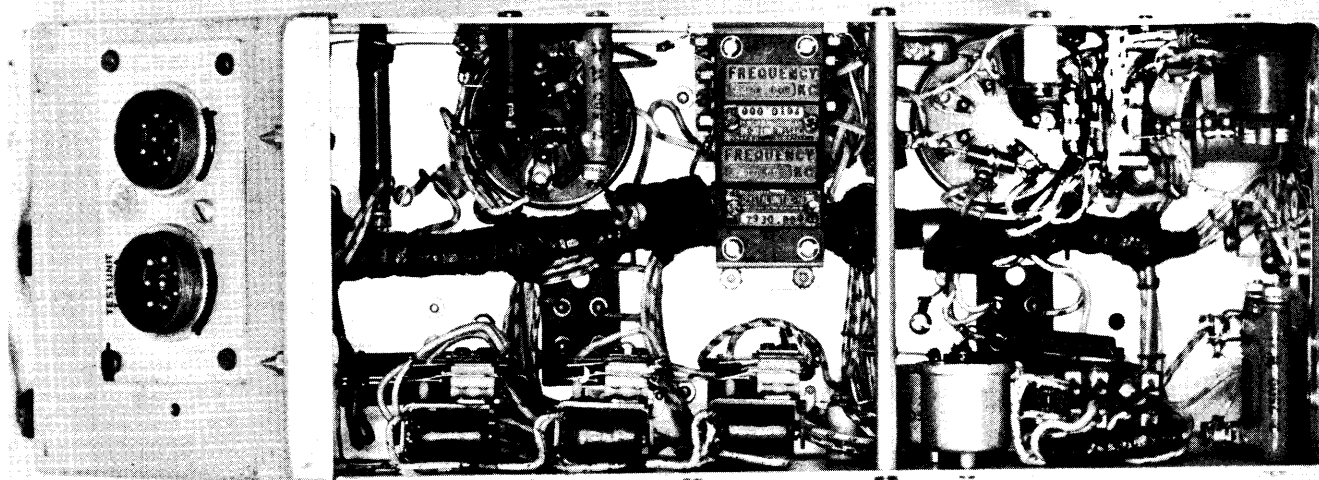


Figure 36

- A—12-volt filament circuit for T-23/ARC-5
 B—New octal plug to replace J-308
 C—Bandswitching motor circuit modifications
 D—Schematic of modified r.f. circuit

Figure 35

UNDER-CHASSIS VIEW OF T-23/ARC-5 TRANSMITTER
 Relays K-303, K-302, and K-305 are mounted to side of chassis. Crystal receptacles are placed between 1625 tube sockets.



- 11—Install a terminal strip having five *ungrounded* terminals in the space left by the removal of the relays.
- 12—Attach the two wires removed in step 5 to one of the terminals of the strip.
- 13—Attach the two wires removed in step 7 to a second terminal of the strip.
- 14—Attach the two solid white wires going to relay K-303 to a third terminal of the strip.
- 15—Locate the yellow and white wire going to relay K-302. Locate the blue and white wire going to relay K-305. Remove and solder these wires together and attach to a fourth terminal of the strip.
- 16—Locate and remove the blue and white wire going to relay K-302. Locate and remove the red, black, and white wire going to relay K-305. Solder these wires together and attach to the fifth terminal of the strip.
- 17—Remove completely the red and white wire attached to the coil of relay K-306.
- 18—Disconnect the 20 ohm resistor-fuse (R-326), and the red, green, and white wire from the ceramic end plate of relay K-306. Solder the resistor and wire together. Tape the joint.
- 19—Cut the other two leads going to relay K-306. Tape each end so they will not short out against the chassis, or to each other.
- 20—Remove relay K-306 from the chassis. Install a cable clamp to hold the cable next to the side of the chassis. Install a terminal strip with one ungrounded tie-point under the relay bolt.
- 21—Attach the 20-ohm resistor to the tie-point.
- 22—J-308, the 7-pin plug on the rear of the chassis, should be replaced with an 8-prong male plug for convenience. Remove the wires one at a time from J-308. Remove the wire from terminal #1 and place it on pin #1 of the tube socket. Do the same with terminal 2. Continue this procedure until all of the wires are transferred. Remove J-308 and mount the male plug in its place.
- 23—Cut all the wires connected to relay K-304. Remove from the chassis the 10-ohm resistor (R-330, brown, black, black) and the 15 μ fd. capacitor associated with K-304. Remove K-304 from the chassis, and in its place substitute a terminal strip having one ungrounded tie-point. Take the green and white wire from the K-304 wiring cable and attach it to the terminal. Tape the other wires separately for insulation.
- 24—Install a lead connecting the wires on the terminal strip to terminal 8 of receptacle J-308 on the front of the unit.
- 25—Locate the two 0.002 μ fd. bypass capacitors (C-329A, B) at the base of the tuning motor. Disconnect the white lead, leaving the green

and white wire connected. Tape the white wire. Short together the two leads coming from the motor. The motor windings are now connected in parallel instead of in series. The motor will now function on 24 volts, a.c., rotating the coil assembly when 24 volts a.c. is applied to pin #8 of J-308.

- 26—Remove the black and white wire from the coil terminal of relay K-301, the antenna relay. Ground this terminal. Tape the wire.
- 27—The sockets of V-301 (oscillator) and V-304 (832-A amplifier) need not be modified for 12-volt filament operation. On socket V-303, the two solid white wires should be disconnected and then attached to the terminal that is occupied by the single black and white wire. The terminal formerly occupied by the two white wires is now jumpered to the ground terminal located next to it.
- 28—Now go to socket V-302 (1625 multiplier). Remove the green and white wire from pin #7 and solder it to pin #1. Ground pin #7. Check all connections. Modification of the transmitter for 144 Mc. is now complete. See figure 36.

Transmitter Modification for 50 Mc.

- 1—Remove tube V-303 (832-A tripler) from the transmitter. Save the tube for a spare.
- 2—Set the transmitter turret on channel D.
- 3—Remove the 20,000-ohm resistors (R-312, R-313) and the 3 μ fd. coupling capacitors (C-315, C-316) from the grid circuit of tube V-304 (832A amplifier).
- 4—Run a jumper wire from pin #6 (grid terminal) of socket V-303 (tripler) to grid pin #6 of socket V-304 (amplifier).
- 5—Run a second jumper from pin #2 (grid terminal) of socket V-303 to grid pin #2 of socket V-304.
- 6—Remove coil turret Z-301 (front turret for 832A amplifier stage). Mark the channel D coil, L-311-D.
- 7—Remove the plate circuit winding, and replace it with 19 turns of #18 enameled wire, close-spaced. Replace the coil in the turret. The 50 Mc. conversion is complete.

A crystal having a frequency between 8.334 Mc. and 9.0 Mc. is required for six-meter operation. Tube V-301 is an oscillator doubler, producing output in the 17 Mc. region. Tube V-302 is a tripler to the 50 Mc. region and tube V-304 is a straight amplifier at six meters.

It is possible to return to 144 Mc. operation by replacing the buffer tube and reworking the grid circuit to the original configuration. If two-band operation is desired, there is no reason why a plug-in board could not be adapted to replace the 832A buffer, in-

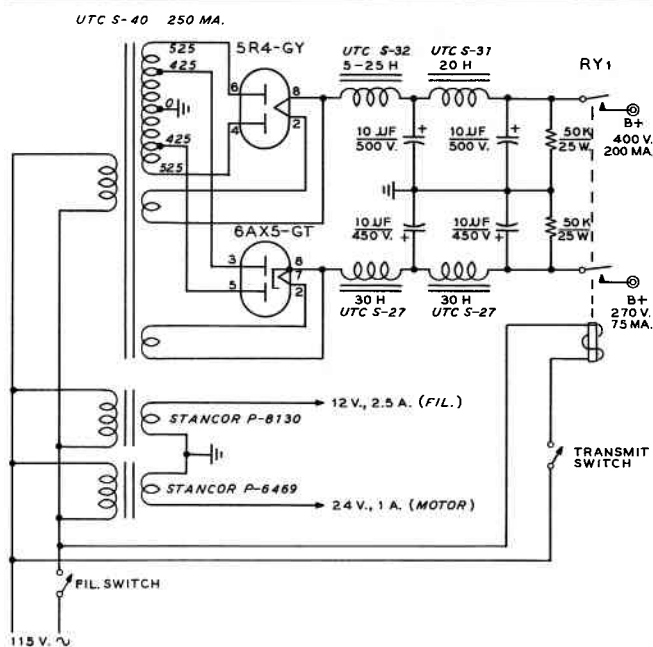


Figure 37
A.C. POWER SUPPLY FOR T-23/ARC-5
TRANSMITTER

incorporating the necessary 50 Mc. circuit changes. In this fashion, one transmitter would serve for both six- and two-meter operation.

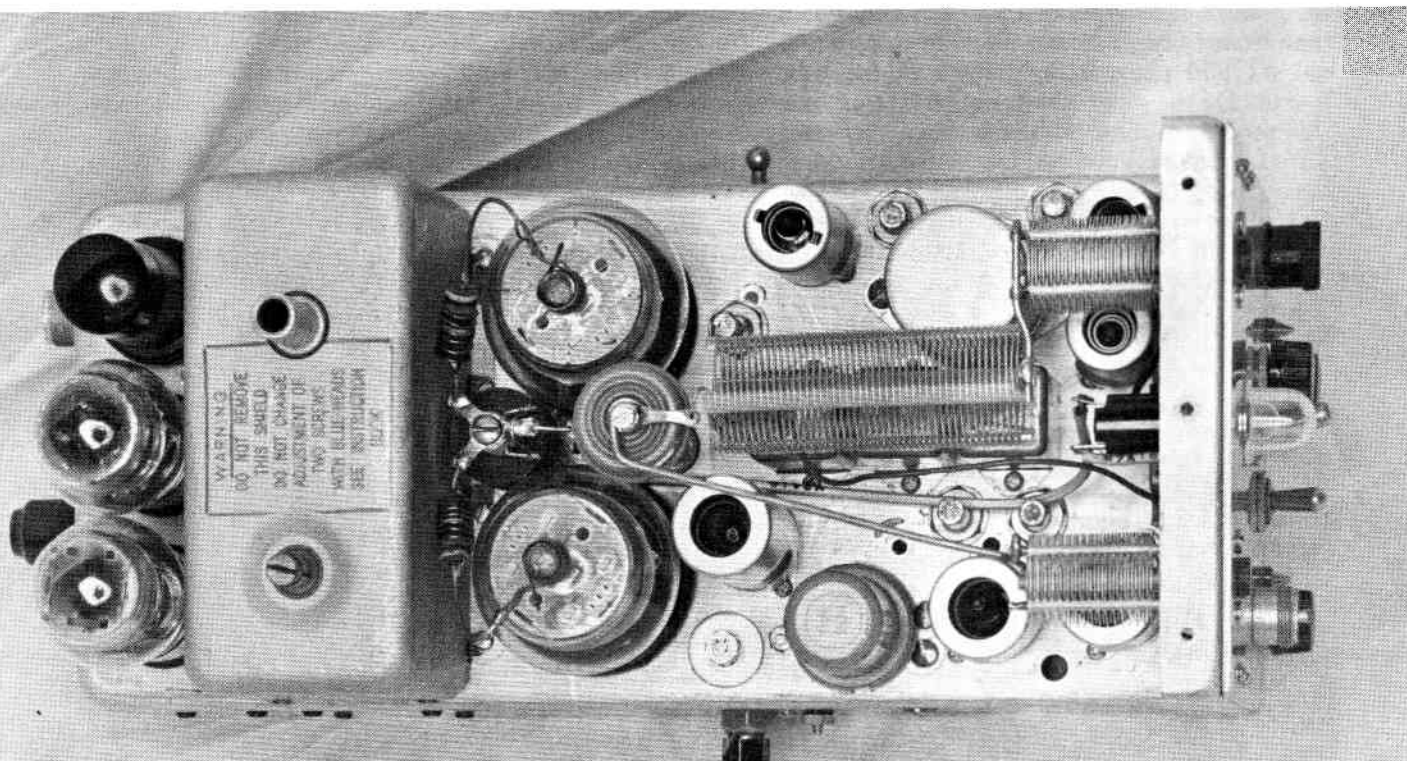
Transmitter Tuning The transmitter may be aligned with the aid of a small neon bulb. A tuning wand may be made from a pencil. Remove the eraser from the end of a wooden pencil and crimp the metal band with a pliers to fit the end of the tuning slugs. Tuning may be facilitated if a drop of penetrating oil is placed on the threads and allowed to stand overnight. The slugs are at a high d.c. potential so it is necessary to wrap the pencil completely with two layers of electrical tape for protection.

First, adjust the oscillator coil (turret Z-302, center, right side) for output at the third harmonic. Use a nearby receiver as a monitor, or check frequency with the aid of a grid-dip oscillator. Next, tune each buffer stage for maximum brilliance of the neon bulb when held near the plate lead of the tube in question. Check for correct frequency tuning with the grid-dip oscillator. Channel D is best suited for operation at the high frequency end of the 144 Mc. band.

Transmitter Power Supply The transmitter requires a power supply delivering 400 volts at 200 ma. for the plate supply, 270 volts at 75 ma., 12 volts a.c. at 2.5 amperes for the filaments, and 24 volts at 1 ampere for the tuning motor. A suitable supply is shown in figure 37. Plate input to the amplifier stage is about 30 watts (400 volts at 80 milliamperes). Note: Turn off the high voltage before you run the tuning motor, or

Figure 38
TOP VIEW OF COMMAND TRANSMITTER CONVERTED FOR
SINGLE SIDEBAND SERVICE

Placement of major components is shown in figure 40. Pi-network circuit for linear amplifier is at right of chassis. Unit shown is for 80-meter operation.



it is possible to blow out the 47-ohm resistor (R-316) in the 832-A plate circuit.

Convert Your BC-458 Into a Single Sideband Transmitter!

The BC-458 is part of the SCR-274N radio equipment. It is a compact v.f.o. transmitter, covering

the range of 5.3–7.0 Mc. (Navy version is the T-21/ARC-5). Four tubes are used in the transmitter: 1626 oscillator, 1629 “magic-eye” tuning indicator, and two 1625 power amplifiers.

This Command transmitter may be easily converted to a phasing-type s.s.b. transmitter for either

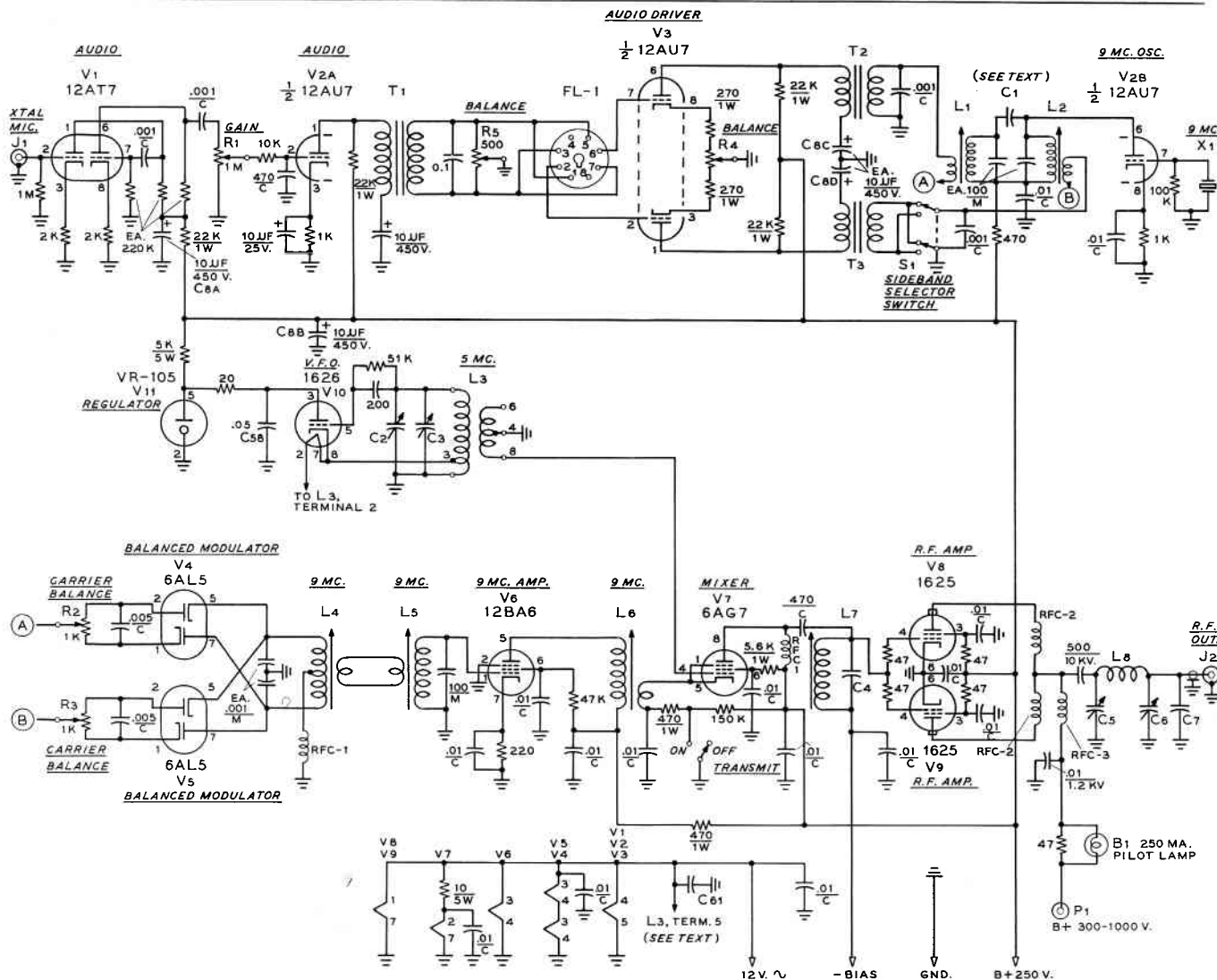


Figure 39
SCHEMATIC, SINGLE SIDEBAND TRANSMITTER

- C-1—3 $\mu\mu\text{fd}$. This capacitor may not be necessary. Leave it out unless carrier balance can not be set with slugs of L-1 and L-2.
- C-2—Original oscillator tuning capacitor, panel-driven
- C-3—Original oscillator padding capacitor
- C-4—See coil table
- C-5, C-6—140 $\mu\mu\text{fd}$.
- C-7—1250 volt mica padding capacitor, 300 — 1500 $\mu\mu\text{fd}$.
- C-8A-B-C-D—10-10-10-10 μfd . electrolytic in metal can.

- FL-1—Barker & Williamson type 350 phase-shift network.
T-1—20K to 600-800 ohms. Thordarson TR-17, or Arrow Sales Co. type TR-29.
T-2, T-3—15K to 200 ohms. Thordarson TR-25, or Arrow Sales Co. type TR-29 (use $\frac{1}{2}$ of secondary winding).
RFC-1—2.5 mh. choke
RFC-2—5 turns #18 e. wire around 47 ohm, 2-watt composition resistor.
RFC-3—2.5 mh. "transmitting type" choke
See figure 43 for coil data

80- or 40-meter operation. Either sideband may be transmitted, and the completed transmitter includes a high stability v.f.o. Peak power output is about 100 watts when a 1000-volt plate supply is used.

The Sideband Circuit

The complete circuit of the converted command transmitter is shown in figure 39. The original oscillator tube and circuitry (V-10) is retained, as well as the 1625 amplifier tubes and sockets (V-8, V-9). The sideband signal is generated at a crystal controlled frequency of 9 Mc. Tubes V-1 and V-2A are the audio stages that develop sufficient voltage from a crystal microphone to drive phasing network FL-1 properly. The two audio output signals from the network are further amplified by tube V-3 and applied in series with the r.f. output of the 9 Mc. crystal oscillator through circuits T2-L1 and T3-L2. Two r.f. signals are available at points "A" and "B". Each signal is amplitude modulated, but of a different r.f. phase. These two signals are applied to the diode balanced modulator (V-4, V-5) through two balancing potentiometers, R-2, and R-3. The signal developed in the output circuit of the balanced modulator (L-4) is a single sideband signal at 9 Mc. The action of the modulator has balanced out the carrier and one sideband, leaving the desired single sideband. Reversing switch S-1 will change the sideband appearing at the output of the balanced modulator. This signal is amplified by V-6.

The 9 Mc. signal must now be changed in frequency by a mixing process to the desired output frequency in either the 80-meter or the 20-meter band. This is done by combining the 9 Mc. sideband signal with the 5 Mc. output signal of the variable frequency oscillator, V-10. Mixing is done in tube V-7. Twenty-meter output is a summation of the two signals (9 Mc. plus 5 Mc. = 14 Mc.) and eighty-meter output is the difference of the two signals (9 Mc. minus 5 Mc. = 4 Mc.). Both signals appear in the plate circuit of V-7, and the desired signal is obtained by tuning the circuit C-4-L-7 to either 20 or 80 meters. Data for this circuit for either band is given in figure 43.

The final step is to amplify the s.s.b. signal to a usable level. This is done in the linear amplifier, V-8, V-9. When operated at 1000 volts plate potential, s.s.b. peak output is over 100 watts, dropping to 20 watts at 300 volts. The transmitter is placed on the air by energizing V-7 when switch S-2 is closed.

V.f.o. operation is obtained by tuning capacitor C-2. The range of 5.0–5.4 Mc. covers the 20-meter band (14.0–14.4 Mc.), and the range of 5.2–5.0 Mc. covers the 80-meter band (3.8–4.0 Mc.). It is a simple matter to increase the setting of the oscillator padding capacitor C-3 to lower the oscillator frequency to 5.0 Mc. at the low frequency end of the dial.

Converting the Command Transmitter

The first job is to strip the Command transmitter of all the parts you do not require. Refer to figure 2 for wiring diagram of original transmitter. Remove all of the original wiring below the chassis except the 1626 oscillator circuit. Remove R-71, C-64, C-66, K-53, C-62 and R-76. Also remove C-65. Leave capacitor C-61. The amplifier capacitor (C-67) of the tuning gang is removed, and a new tuning shaft for oscillator tuning capacitor C-63 is made from the knob and shaft from the variable link coupling coil above the chassis (part of T-54). Above the chassis, the loading coil, antenna relay, and plate coil T-54 are removed.

The new parts, tube sockets, and other components are now laid out atop the chassis, as shown in figure 38, and the chassis is drilled. A new aluminum panel is placed over the old front panel of the transmitter. At the rear of the chassis a miniature coaxial receptacle (J-2) is mounted, and the original power plug is removed and an 8-pin socket substituted. Also mounted on the back apron is a high voltage terminal (Millen). Placement of the components is indicated in figures 40 and 41.

Wiring the S.S.B. Transmitter The filament circuits are wired first. Next, the oscillator coil (L-3, figures 39 and 40, old T-53, figure 2) is wired. Terminal #5 of L-3 is attached to capacitor C-61, and the opposite terminal

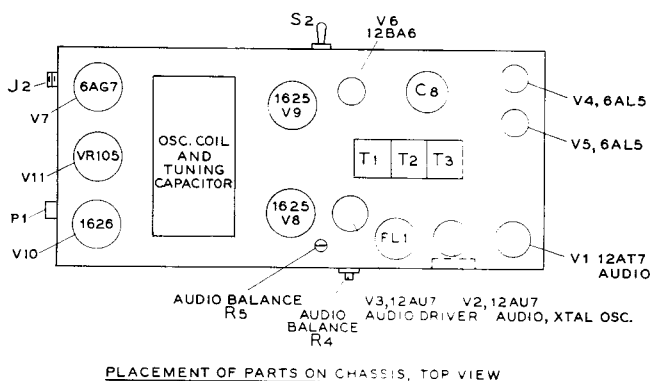


Figure 40
Placement of parts on chassis, top view

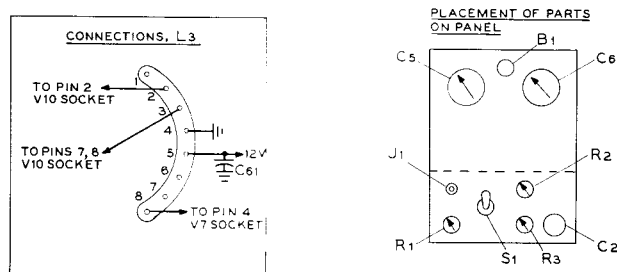


Figure 41
Panel layout and coil connections, L-3

of C-61 is grounded. The "hot" terminal of C-61 is wired to the 12-volt filament circuit. Pins #1, 6 and 7 of L-3 are left empty.

The next step is to wire the audio stages and the audio filter. Mount the $\frac{1}{2}$ -watt resistors and ceramic capacitors directly on the socket pins to conserve space wherever possible. Capacitor C8A-B-C-D is a four-section can mounted to the chassis, and balance control R-5 is on the chassis deck, above R-4. Because of restricted space, R-5 is a subminiature control, only $\frac{3}{8}$ " diameter (CTC type "Mini-pot").

Now, wire the crystal oscillator, balanced modulator, and 9 Mc. amplifier stages. Wind coils L-1, L-2, L-4, and L-5 according to the data of figure 42. Mount 9 Mc. crystal X-1 to the inner wall of the chassis by means of a small aluminum clamp. Capacitor C-1 is merely the capacitive coupling between coils L-1 and L-2, which are separated about one inch, center to center. The leads from the link coils to potentiometers R-2 and R-3 are twisted together. Silver mica capacitors are employed across L-1, L-2, L-4, and L-5, and also across L-7.

Finally, wire the mixer, V-7, and the 1625 amplifier stage. Plate coil L-8 is supported at one end by the stator of loading capacitor C-6, and at the opposite end by the 500 μfd . TV-type coupling capacitor, which is mounted on a small metal bushing between the 1625 sockets. Choke RFC-3 is placed between the capacitor and the oscillator shield, as seen in the top

- L-1, L-2, L-5, L-6—25 turns #22 e. wire, slug-tuned form, 5/16" diam. Link 4 turns over "cold end"
- L-3—Original oscillator coil, see figure 41
- L-4—8 turns #16 e., slug-tuned form, 5/16" diam. Link, 1 turn at center
- L-7—3.5 Mc. 39 turns #26 e., slug-tuned form, 5/16" diam., tuned by 150 μfd . capacitor (C-4), 14 Mc., 25 turns #22 e., slug-tuned form, 5/16" diam., tuned by 56 μfd . capacitor (C-4).
- L-8—3.5 Mc. 46 turns #20, 16 turns per inch, 1" diam. (3. & W. 3015) 14 Mc. 12 turns #14, 1" diam., 1 - 5/8" long.

Figure 43
COIL TABLE FOR S.S.B. EXCITER

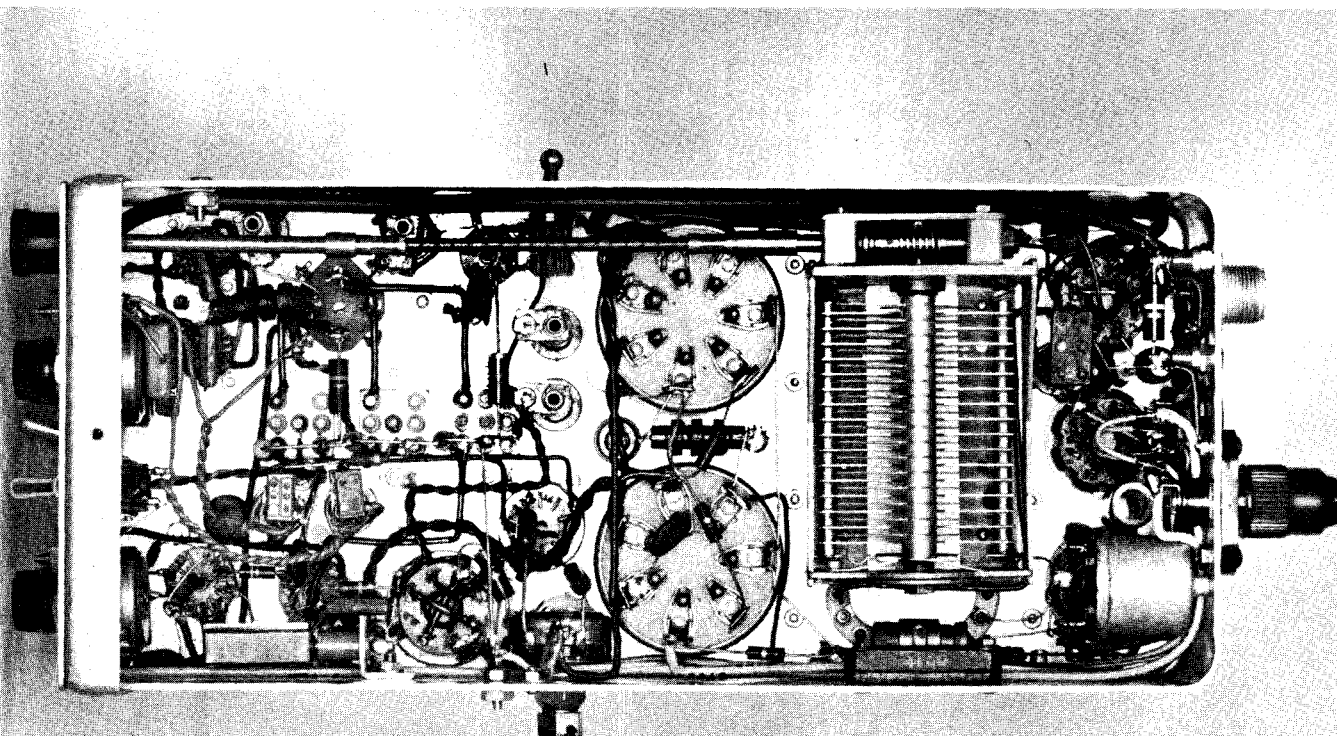
view photograph. Capacitors C-5 and C-6 are mounted to the front panel, with their rotors grounded to the panel. A short length of coaxial line is run from capacitor C-6 to coaxial receptacle J-2 mounted on the rear of the chassis. Ground the outer shield of the line at both ends.

As a last step, check all your wiring against figure 39.

Adjusting the S.S.B. Transmitter Adjustment of this transmitter is done in steps. First, plug in all tubes and determine that the filaments operate when 12.6 volts is applied between the filament pin and ground of the power plug. Remove all tubes except the oscillator

Figure 42

Under-chassis view of S.S.B. transmitter. Audio system components occupy space of old amplifier tank capacitors. Coils L-1 and L-2 are mounted behind one 1625 tube socket, near center of chassis. Coaxial lead runs from C-6 to coaxial output jack J-2 on rear of chassis.



tube V-10 and the regulator tube, V-11. Apply 300 volts to the transmitter and check v.f.o. operation by listening to the 5 Mc. region in a nearby receiver. Adjust capacitor C-60 (atop the chassis, see figure 2) to bring the 5.3 Mc. dial point down to 5 Mc. Now, plug in tube V-2 and listen at 9 Mc. Adjust the slug of coil L-2 until the crystal stage oscillates.

You now need an audio oscillator for the next adjustment step. A high quality, low distortion oscillator (such as the Heathkit AG-10 or AG-9A should be employed). A low level, 1200 cycle audio signal is injected in microphone jack J-1. Coils L-4, L-5, and L-6 are peaked for maximum 9 Mc. signal as measured with a vacuum tube voltmeter connected from pin #5 of socket V-7 to ground, or with a antenna lead of a nearby receiver held close to pin #5.

As long as the audio signal is applied, a signal at the sideband frequency will appear in circuit C-4—L-7. Let us assume, as an example, that this circuit is tuned to 80 meters. Tune your receiver to 80 meters and listen for the signal. You will hear a signal, modulated with the 1200 cycle tone at a frequency that is the difference between 9 Mc. (the crystal frequency) and the frequency of the v.f.o. Adjust L-7 for maximum signal. Next, turn off the audio signal, and adjust carrier balance potentiometers R-2 and R-3 for minimum signal.

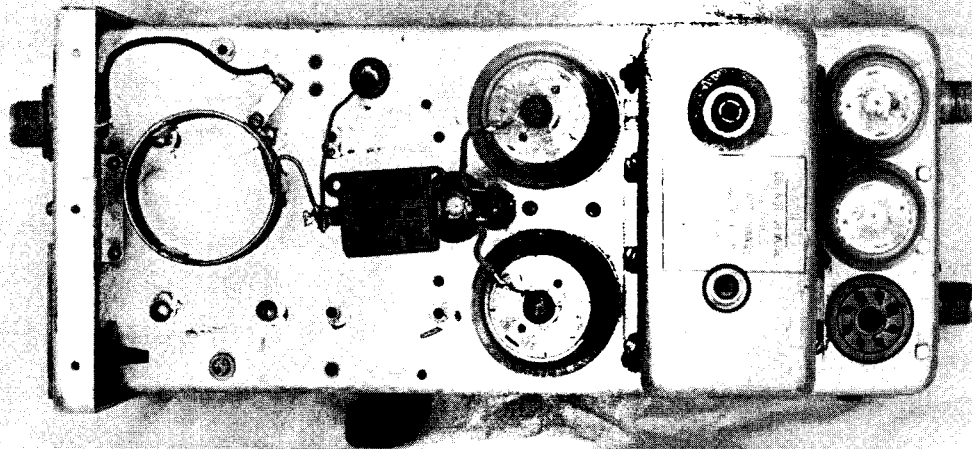
The audio balance controls and coils L-1 and L-2 are best adjusted with the aid of an oscilloscope using "ripple" patterns. These adjustments are covered in detail in the *RADIO HANDBOOK* (published by Editors and Engineers, Summerland, Calif.), or in the *Handbook Single Sideband for Radio Amateurs*, published by the American Radio Relay League. In brief, the vertical plates of the 'scope tube are link-coupled to coil L-6, and oscillator tube V-10 is removed, leaving only the 9 Mc. signal input to V-7. The 'scope

pattern will have a modulation "ripple" upon it. Listening to the 9 Mc. signal in a nearby receiver will allow you to hear the 1200 cycle audio tone impressed upon the speech system. During adjustments, the audio level should be held as low as possible to prevent overloading the phasing system of the transmitter. Couple the receiver to coil L-6 and reduce the gain to prevent overloading. Now, adjust balance controls R-5 and R-4 for minimum "ripple" on the 'scope pattern. Also adjust the slugs of coils L-1 and L-2 for minimum ripple. Keep the audio level as low as possible, and go over the adjustments several times. Also rebalance the carrier balance controls R-2 and R-3 for minimum pattern. Reverse sideband switch S-1 and recheck your adjustments. You should strive to obtain minimum "ripple" regardless of the setting of switch S-1. Once this point has been reached, disconnect the audio generator and 'scope and connect a microphone to J-1. You should hear a clean s.s.b. signal at 9 Mc.

Linear Amplifier Adjustment Plug in the 1625 tubes and apply about —18 volts bias (use flashlight batteries or small "C" batteries) and jumper high voltage terminal P-1 to the 250 volt supply, placing 250 volts on the plate circuit of the tubes. Resting plate current will be about 90 milliamperes or so. Unbalance carrier control R-2 or R-3 and you will obtain an 80-meter carrier in the plate circuit of the linear stage. You can now resonate and tune this stage like any other amplifier. For 80-meter operation, capacitor C-7 must be placed across the output jack J-2. The value of this capacitance depends upon the impedance of the antenna system, and will vary between 300 $\mu\text{fd.}$ and 1500 $\mu\text{fd.}$ As a starter, parallel two sections of a broadcast-type variable capacitor and use it for C-7. Set it at maximum capacity.

Figure 44
"COMMAND"
TRANSMITTER MAY
EASILY BE
CONVERTED INTO
HIGH POWER S.S.B.
LINEAR AMPLIFIER

250 watts peak power is run by inexpensive 1625 tubes (center). Voltage regulator tubes are at rear of chassis.



After you have become familiar with operation at 250 volts, you can boost the plate voltage to 1000 volts or so. The bias voltage for the 1625 tubes should be raised until the no-signal plate current is about 35 ma. at 1000 volts. For other plate voltage values, the bias should be adjusted so that the product of the voltage and the no-signal plate current results in a power input of 35 watts to the two tubes. Under full voice input signal, the plate current will kick up to 120 milliamperes or so.

Convert Your Command Transmitter to a S.S.B. Linear Amplifier

The Command transmitter makes an excellent linear amplifier for 40- or 80-meter operation, capable of running a peak power input of 250 watts. It makes a good linear amplifier for the 10A or 20A sideband exciter, or for any s.s.b. exciter capable of delivering a few watts of power in the 40- or 80-meter amateur band.

For 80-meter operation, the 3-4 Mc. (BC-696, or T-19 ARC-5) or the 4-5.5 Mc. (BC-457, or T-20/ARC-5) transmitter may be used. For 40 meters, the 5.3-7 Mc. (BC-458, or T-21 ARC-5) or the 7-9.1

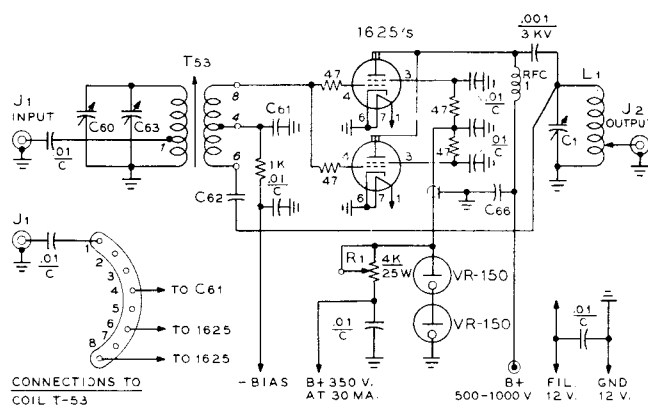


Figure 45
SCHEMATIC, S.S.B. LINEAR AMPLIFIER
MADE FROM A "COMMAND"
TRANSMITTER

C-1—300 $\mu\mu\text{fd}$. Bud MC-1860

L-1—Adjust to tune to output

C-1' nearly fully meshed. Air-Dux 1610, or B&W 3907-1 coil stock (2" diam., 10 turns per inch). Adjust antenna tap for optimum loading

RFC-1—2.5 mh. choke "transmitting type."

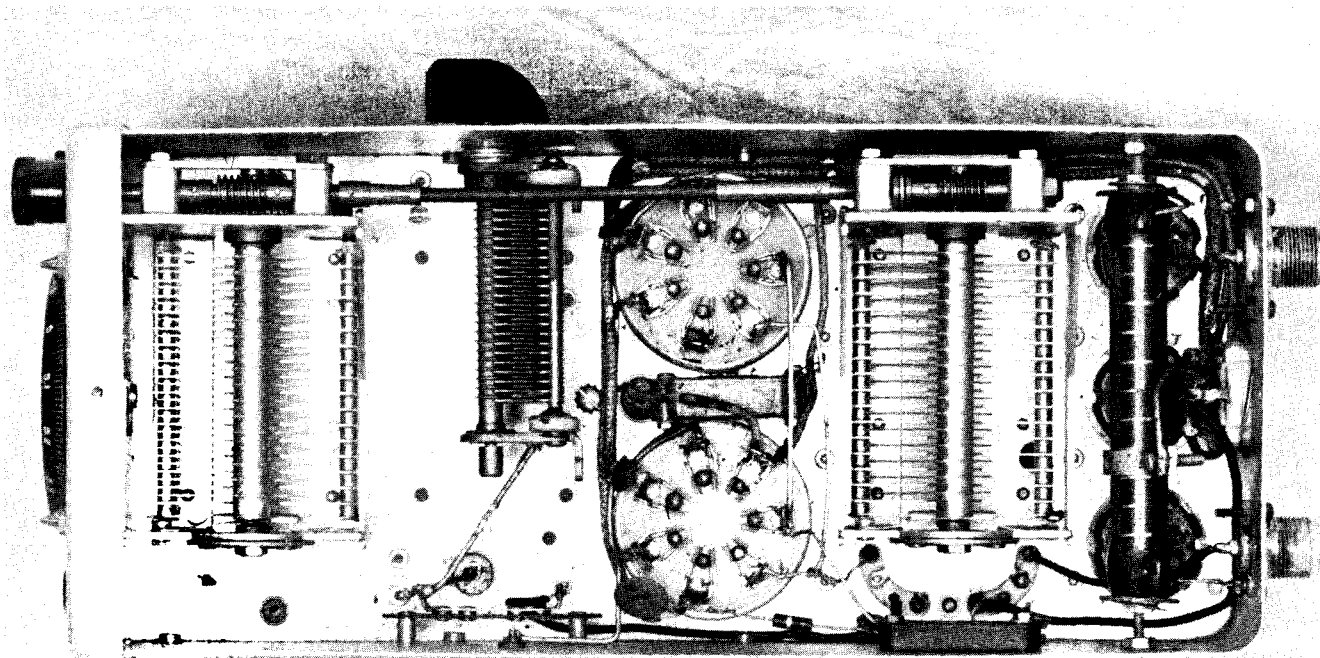


Figure 46

UNDER-CHASSIS VIEW OF S.S.B. LINEAR AMPLIFIER

Screen resistor R-1 is mounted to rear of chassis above the voltage regulator tube sockets. Plate tuning capacitor C-1 is adjustable through side of chassis. Shielded wire is employed for filament, screen, and bias leads. Tuning capacitor near dial is not used, serving only as a bearing for extension drive shaft.

Mc. (BC-459, or T-22/ARC-5) transmitter may be used. Power requirements are 12.6 volts at 0.9 amperes, 350 volts at 35 ma., and 500 to 1000 volts at 150 ma. plate potential.

Conversion to S.S.B. Service

This conversion entails the removal of the oscillator and auxiliary equipment, and the conversion of the oscillator coil to form an amplifier grid coil. Voltage regulator tubes are added to the screen circuit of the final amplifier. A new amplifier plate circuit is also required.

The first step is to remove the unwanted components. Beneath the chassis, remove R-71, C-58, C-64, and all small components on the three rear tube sockets. Remove R-75, R-76, and auxiliary padding capacitor C-67. Remove relay K-53, and resistor R-78. Above the chassis, remove the antenna relay K-54 and the loading coil. Remove the plate coil T-54 and the rotary link control. Remove all loose leads and wires.

Wiring the Linear Amplifier

A schematic of the converted Command set is shown in figure 45, and top and bottom photographs are given in figures 44 and 46. A five-prong socket replaces the rear power receptacle, J-64. The VR-150 and VR-105 regulator tubes are placed in two empty octal sockets at the back of the chassis.

Tap #1 on the old oscillator coil (T-53) is used as the r.f. input circuit for the amplifier. Excitation may be controlled by tuning the main dial of the transmitter for greatest grid drive. The plate circuit of the linear amplifier uses a new tuning capacitor, C-1. The old, ganged capacitor is not used, but is retained to act as a bearing for the oscillator tuning shaft.

Plate coil L-1 is mounted above the chassis as seen in figure 44. It should be pruned so that resonance on 80 meters occurs with C-1 almost fully meshed, and 40-meter resonance occurs with C-1 about 75% meshed. The antenna tap on L-1 is connected to a coaxial receptacle mounted on the front panel

of the amplifier. An external 0–250 ma. d.c. milliammeter may be placed in the B-plus lead for tune-up purposes. Pins #6 and #7 of each 1625 socket are grounded to the metal shell, and the “hot” filament line is bypassed with a 0.01 μ fd. ceramic disc capacitor. Pin #3 of each socket is also bypassed to the metal shell with a similar capacitor.

Linear Amplifier Operation

Bias voltage is applied to the amplifier, and the B-plus lead is temporarily connected to the 350 volt supply for tune-up purposes. Bias voltage is varied (about –18 volts) until the no-signal plate current of the amplifier is about 90 milliamperes. A small s.s.b. signal is applied to the input and the tuning dial varied until a rise in the plate current of the amplifier is noted. It may be necessary to adjust padding capacitor C-60 or the slug of coil T-53 to obtain resonance. Plate tuning capacitor C-1 is tuned for plate circuit resonance, and the tap on coil L-1 is adjusted for optimum antenna loading. Resistor R-1 should be adjusted for about 30 ma. of regulator tube current. When the amplifier is operating properly, the 1625 plate voltage may be raised to a maximum of 1000 volts. Bias should be adjusted to provide a no-signal plate current of about 35 ma. Under full excitation, maximum average plate current will be about 125 ma., providing a s.s.b. input signal of about 300 peak watts. The antenna tap on coil L-1 may be readjusted at the higher value of plate voltage for optimum antenna loading.

Using the Western Electric 701-A Tetrode

The large Western Electric 701-A tetrode is available on the surplus market for a low price. The physical size of the tube (7½" high, 4¼" diameter) suggests that it would make a good high power r.f. amplifier. The tube is a tetrode intended for pulse modulator operation. It has an indirectly heated cathode, with the plate terminal of the tube at the top of the glass bulb. Connections to the terminals and the outline of the tube are shown in figure 47. A modified Western Electric 153A socket may be used, or the experimenter can easily build his own socket. The tube should be mounted in a vertical position, and there should be a free circulation of air around the glass envelope.

The pulse modulator ratings of the tube are:

Heater Voltage, 8.0 volts, a.c. or d.c.

Heater Current, 7.5 amperes.

Maximum plate voltage (pulse), 12,500 volts.

Maximum screen voltage (pulse), 1,200 volts.

Average plate current (pulse), 80 ma.

Peak pulse plate current, 10 amperes.

Plate dissipation (pulse), 100 watts.

Screen dissipation (pulse), 15 watts.

The suggested class-C operating conditions for amateur service are:

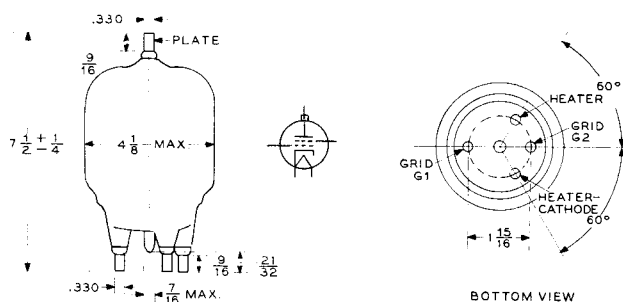


Figure 47
OUTLINE DRAWING OF W.E. 701-A
VACUUM TUBE, SHOWING TERMINAL
CONNECTIONS

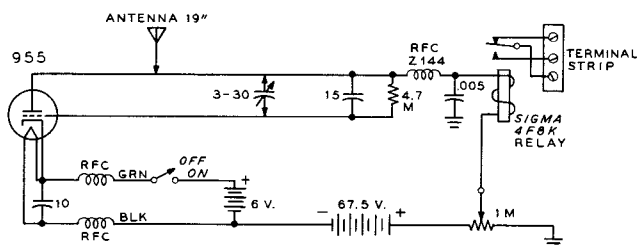


Figure 48
SCHEMATIC, MODIFIED BC-1253
METEOROLOGICAL TRANSMITTER

Filament voltage, 7.5 volts.					
Filament current, 7.0 amperes.					
Plate Voltage	2000	2500	3000	3500	(volts)
Plate current	350	300	250	250	(ma.)
Power Input	750	750	750	875	(watts)
Plate dissipation	220	200	160	175	(watts)
Screen voltage	400	400	400	400	(volts)
Screen current	40	40	40	40	(ma.)
Screen dissipation	20	20	20	20	(watts)
Grid voltage	-150	-150	-150	-150	(volts)
Grid current	15	15	15	15	(ma.)

Note: It is suggested that a 6Y6-G be used as a screen clamper tube to protect the 701-A from excessive screen dissipation.

Inter-electrode capacitances:

Input	15.6 $\mu\mu\text{fd.}$
Output	8.5 $\mu\mu\text{fd.}$
Grid-plate	0.16 $\mu\mu\text{fd.}$

Converting the BC-1253 to a Sensitive Radio Control Receiver

The BC-1253 meteorological transmitter, available in quantity in the surplus stores can easily be converted to an excellent radio control receiver, featuring high sensitivity, good stability, and light weight. The receiver is suitable for use in model airplanes, boats, etc. The BC-1253 was originally used in weather balloons to send upper-atmosphere weather information back to earth. The transmitter is contained in a small, strong cardboard box that is attached to the sounding balloon. A lightweight battery pack accompanies the transmitter on its flight into the heavens.

The BC-1253 employs a single 955 acorn triode tube as a milliwatt oscillator, with the socket of the oscillator built into the end of a silver-plated tank circuit. The converted circuit of the oscillator is shown in figure 48. Note that the only steps necessary for the conversion are to remove the unnecessary components, change the value of the 955 grid resistor, and make the wiring changes shown.

Conversion to a Radio Control Receiver

Conversion to a Radio Control Receiver The original transmitter circuit uses several connections on a socket strip that it is mounted on. All connections to this strip are removed. To do a neat job, the contact pins should be

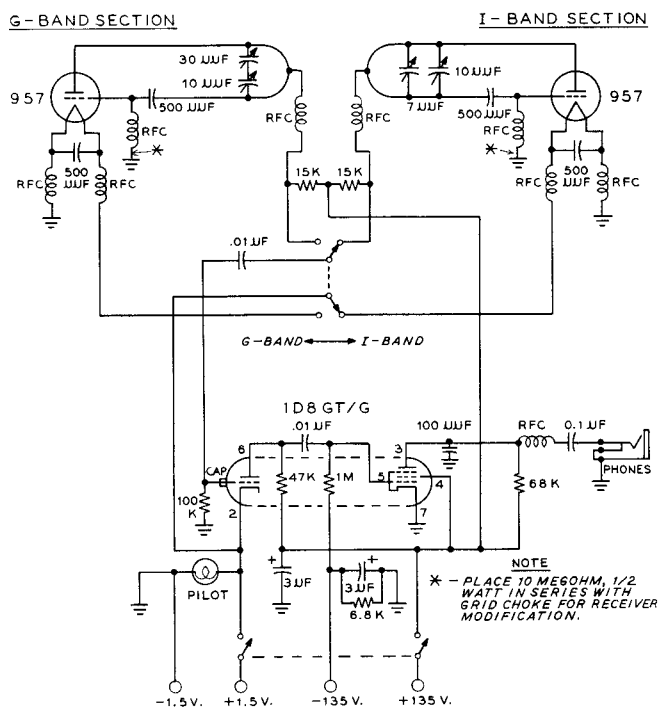


Figure 49
SCHEMATIC, MODIFIED BC-1066 I.F.F.
TEST SET

drilled off and the space provided used to mount the additional parts. It is necessary to add a 3–30 $\mu\mu\text{fd.}$ variable compression trimmer capacitor across the tuned circuit line. It will be necessary to slide the trimmer up and down the lines while adjusting the capacitor to hit the 2 meter (144 Mc.) amateur band. Varying the antenna tap and the tuning capacitor will permit the detector to remain in oscillation across the complete band.

A super-regenerative detector circuit is employed for maximum sensitivity. For optimum results, the plate circuit relay (Sigma type 4F) should be set to pull in at 1 milliampere of plate current. This can be checked by connecting the relay coil in series with a 50K potentiometer, a 45 volt battery, and a milliammeter. Adjust the point spacing of the contacts and the spring tension so that the relay pulls in at about 1 milliampere, and drops out at about 0.8 ma. Now, insert the relay back into the receiver circuit and adjust the variable plate voltage control until the relay pulls in. Next, back off slightly on the control until the relay drops out. A nearby 2-meter r.f. signal picked up by the receiver should now cause the relay to pull in. Adjust the antenna tap for maximum receiver sensitivity.

Converting the BC-1066 to a 144 Mc.—220 Mc. Receiver

The BC-1066 Test Equipment is a dual v.h.f. oscillator intended to check the operation of the SCR-695 "I.F.F." radio equipment. The BC-1066 consists of two

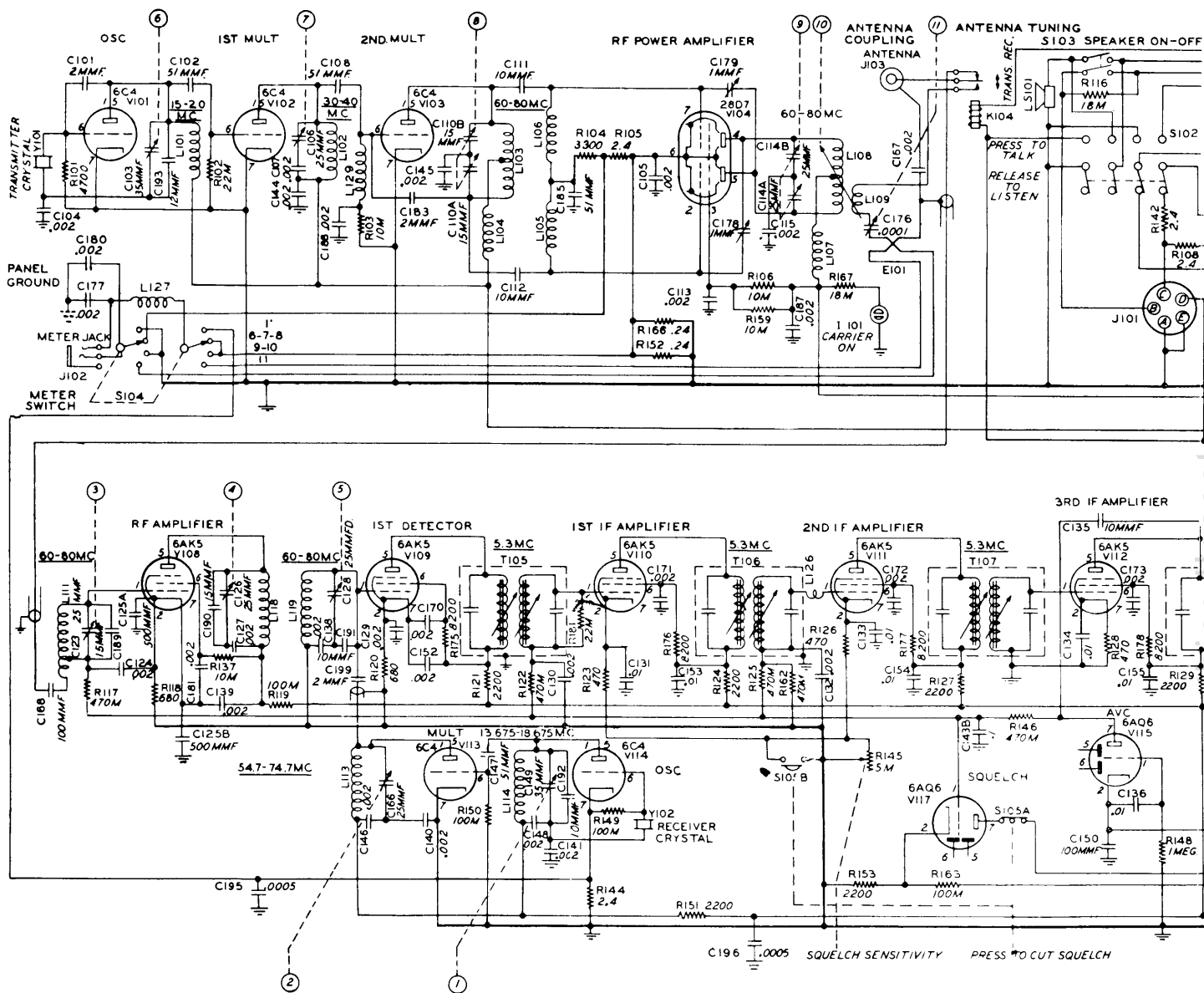


Figure 50
SCHEMATIC, NAVY TYPE COL-43065 (MBF)
TRANSMITTER-RECEIVER

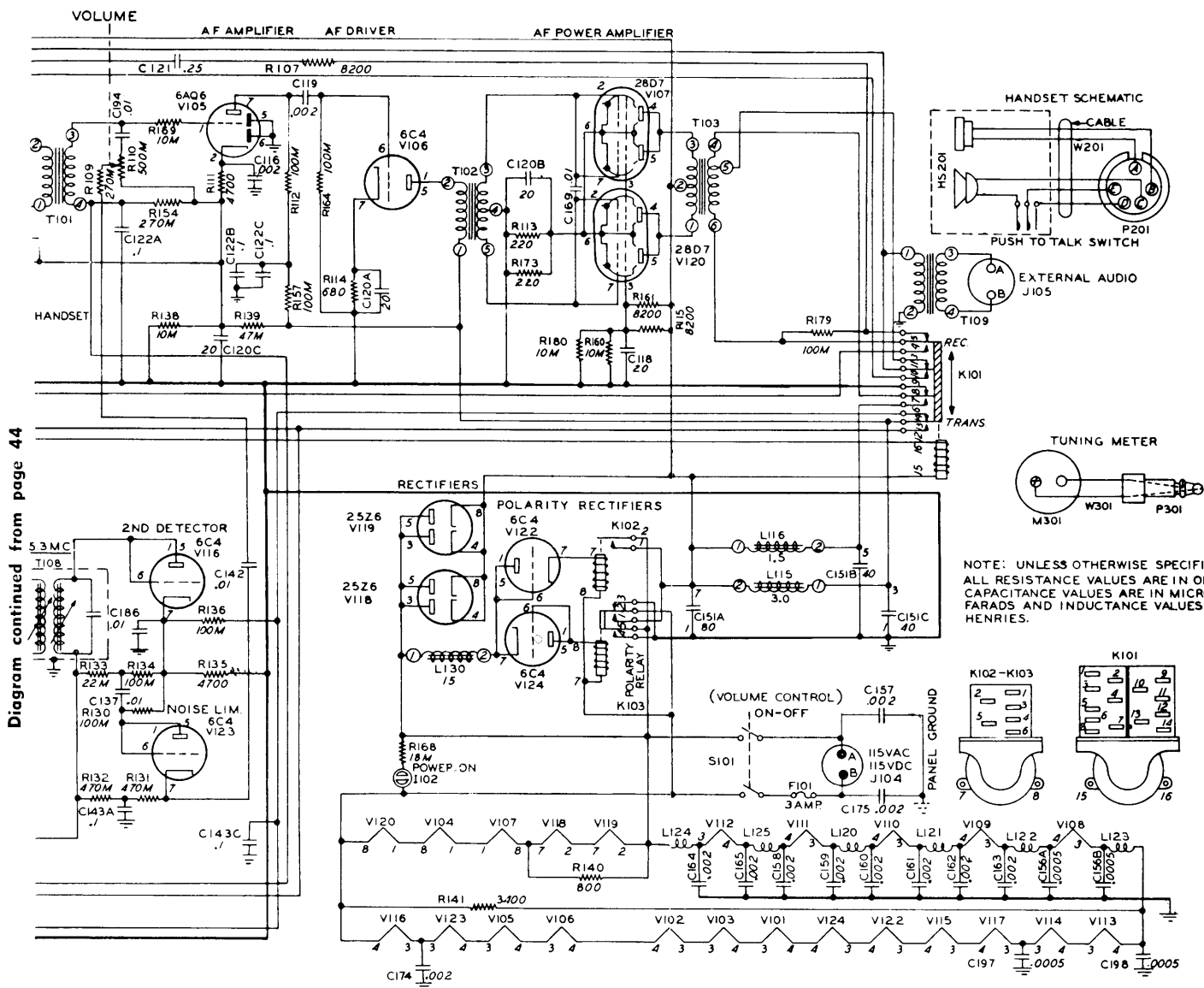


Figure 50
SCHEMATIC, NAVY TYPE COL-43065 (MBF)
TRANSMITTER-RECEIVER

super-regenerative detectors, tunable over the two I.F.F. bands. The weak pulses of the detectors were picked up by the I.F.F. set, which responded by returning a series of coded pulses which could be heard by the receiver portion of the BC-1066. This inexpensive surplus item consists of two type 957 acorn triode tubes used as v.h.f. detector-oscillators, and a 1D8-GT audio amplifier. The two tuned circuits are tunable over ranges close to the 144 Mc. and 220 Mc. amateur bands. A panel switch (I-band: G-band) selects the audio output of either detector. The audio is amplified by the 1D8-GT tube.

Conversion to a V.H.F. Receiver The BC-1066 can be converted to a sensitive receiver for the amateur 144 Mc. and 220 Mc. bands. The original circuit of the unit is shown in figure 49. It is only necessary to unground the end of each r.f. choke in the 957 circuits. In series with this choke, connect a 10 megohm, $\frac{1}{2}$ -watt resistor to ground.

The G-band receiver can be tuned up to the 220 Mc. band by adjusting the padding capacitor, and the I-band receiver will tune to 144 Mc. with a simple adjustment of the padder capacitor. The BC-1066 draws only a small amount of current, and a size D cell, plus two small 67½-volt batteries will last for many months. It is an excellent receiver for "Field Day" or any portable v.h.f. use. Two $\frac{1}{4}$ -wave whip antennas mounted atop the case and link coupled to the respective tuned circuits will be satisfactory for portable work.

Conversion of R-9/APN-4 for 115 Volt A.C. 60 Cycle Operation

R-9/APN-4 makes a good 160 meter receiver when converted for 50–60 cycle operation. The receiver operates on four preset channels, any one of which can be selected by the main channel switch. In this conversion, the power supply is adapted for operation from your light line, and the receiver is modified for operation without auxiliary equipment. The 1400-volt supply in the receiver for the Loran 'scope tube is not used.

Receiver Section Conversion Check off each step as you do the conversion.

- 1—Remove J-104 (red) from the panel and install a phone jack in its hole. Solder the center wire of the coaxial cable to the tip connection of the jack.
- 2—Remove the wires from the "Filter In–Out" switch. Splice the wires together near the 6SL7 socket. Tape the wire joint.
- 3—Cut away the wire between pin #8 of 6SN7 socket and pin #1 of 6SL7 socket.
- 4—Remove J-103 (blue) but leave its wire. Install in its hole a 3K potentiometer. Connect the wire to the center terminal of the potentiometer, and ground one other terminal. This is now the audio volume control.

Power Supply Section Conversion 1—Remove J-102 (yellow) and switch S-103 (line voltage).

- 2—Remove the wires between pins #3 and #4 of J-106 and the power switch.
- 3—Unsolder the black wire (which goes to terminal #1 of T-105) from standoff insulator and resolder to terminal #3 of J-106.
- 4—Remove the white wire from terminal #3 of T-105 and connect terminal #3 of T-105 to pin #4 of J-106. Tape the end of the white wire.
- 5—On T-105: Move blue (blue-red on R9-B receiver) wire from terminal #2 to terminal #3. Solder other end of this wire to end-lug of spare fuse holder.
- 6—Connect side-lug of spare fuse holder to one side of old "Filter Out–In" switch. Solder white wire which went to S-103 to other terminal of old "Filter Out–In" switch.
- 7—Remove blue wire from end-lug of F-101 and connect in its place the white-black lead which used to go to the line voltage switch. Tape the blue wire end.
- 8—Remove the voltage control potentiometer R-121 together with its series resistor and re-install in old line voltage switch mounting hole. Ground the loose end of resistor R-128.
- 9—Move red-black wire from terminal #2 of T-104 to the point on the terminal board where blue (blue-red on R9-B receiver) wire from R-121 originally terminated (see step 5). Solder the other end of this red-black wire (find correct one of two) to potentiometer R-121 in its new location.
- 10—Connect center terminal of R-121 to point on terminal board where green wire was connected.
- 11—Install switch S-103 in J-102 hole. Run wire from the center terminals to terminal #12 of T-104. Connect lower pair of terminals to "hot" lug of pilot lamp receptacle.
- 12—Protection from heavy current surge must be used in series with primary winding of power transformer. Place three 200-watt, 115 volt light bulbs in series with the line, using primary terminals #1 and #3. Safe operating voltage for the transformers is indicated by a voltage of $5\frac{1}{2}$ across terminals #12 and #13. Ninety-eight to 100 volts should be indicated across terminals #1 and #3 for good operation.

Converting the MBF Transmitter-Receiver for 6 Meters

The Navy MBF transmitter-receiver (Navy type COL-43065) is designed to operate in the 60–80 Mc. range. It will operate from 115 volts, a.c. or d.c. The MBF has crystal controlled receiving and transmitting channels, but may be converted for manual receiver tuning. The schematic of the MBF is shown in figure 50. The following tubes are used, with their filaments connected in series-parallel across the 115 volt line:

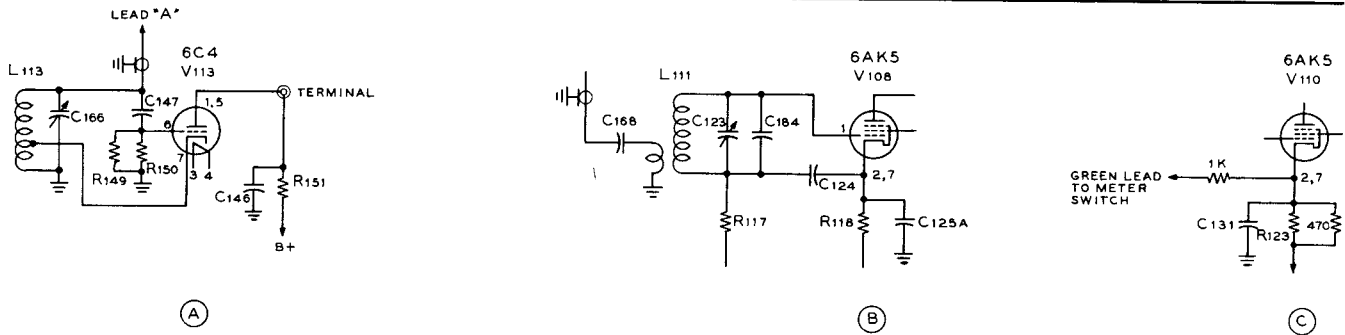


Figure 51

A—Modified oscillator circuit for MBF receiver section
 B—Modified r.f. circuit for MBF receiver section
 C—S-meter circuit modification

Transmitter tubes

- V-101—Transmitter oscillator, 6C4
- V-102—Frequency multiplier, 6C4
- V-103—Second multiplier, 6C4
- V-104—R.f. power amplifier, 28D7

Receiver tubes

- V-108—R.f. amplifier, 6AK5
- V-109—Mixer, 6AK5
- V-110—5.3 Mc. i.f. amplifier, 6AK5
- V-111—5.3 Mc. i.f. amplifier, 6AK5
- V-112—5.3 Mc. i.f. amplifier, 6AK5
- V-113—Injection frequency multiplier, 6C4
- V-114—Injection crystal oscillator, 6C4
- V-115—A.v.c. amplifier, 6AQ6
- V-116—Second detector, 6C4
- V-117—Squelch amplifier, 6AQ6
- V-123—Noise limiter, 6C4

Modulator and Power supply

- V-105—A.f. amplifier, 6AQ6
- V-106—A.f. driver, 6C4
- V-107—Modulator, 28D7
- V-118—Rectifier, 25Z6
- V-119—Rectifier, 25Z6
- V-120—Modulator, 28D7
- V-121—Not used
- V-122—Relay rectifier, 6C4
- V-124—Relay rectifier, 6C4

Receiver Modification for 50 Mc. Operation First, remove the MBF from the case, and set it on end with the receiver section up.

Remove the screws and cover which is over the first two receiver stages. The long bar on the back should also be removed. This bar connects the receiver chassis to the transmitter chassis. There are also several bolts holding the receiver chassis to the main chassis which should be removed. Place all of the nuts, bolts, and washers in a safe place as you will need them later. Now the receiver chassis is loose with the exception of the wiring passing through a grommet to the main chassis. Do not turn the equipment on when disassembled, for if the chassis touches the front panel you will either blow a fuse or receive a shock.

Remove the receiver crystal holder Y-102, the first variable capacitor C-192, and the capacitors and resistors from the first oscillator tube socket V-114. Save all parts. Leave the 6C4 tube filaments in series with the rest of the circuit. Leave the tube in the socket. Now, remove oscillator coil L-114, being careful not to break the form. Remove the solvent from the coil form bolts, and it will be easier to remove the coil.

The second 6C4 (V-113) will now become the tunable oscillator for the receiver. The new oscillator circuit is shown in figure 51A. Compare it with the existing circuit of figure 50. First, take the 100K resistor (R-149) that you removed from the old oscillator stage and connect it in parallel with R-150, the grid resistor of tube V-113. The old coupling capacitor (C-147) is returned to the rotor of tuning capacitor C-166.

Remove capacitor C-140 from pin #7 of socket V-113. Remove the wire from pin #7 and clip it off. Remove capacitor C-146 attached to the coil and to tuning capacitor C-166. Now, take out the plate coil, L-113. This coil has 5 turns. Remove the wire, and rewind it with similar size wire, 8 turns tapped approximately one turn from the bottom. Leave the coil wire ends long and run them through the eyelets on the coil form, the bottom wire about 1" long, and the top wire about 3" long. Put the new coil back in place and rewire as shown in figure 51.

Lead "A" is the original length of coaxial cable coupling the stage to the mixer tube, V-109. It connects to its original place, at the top of the coil, or to the variable capacitor. The plate terminal of V-113 is attached to the top of the tall stand-off insulator, which is bypassed to ground with capacitor C-146 which was removed previously. Make sure that one terminal of the variable capacitor is grounded, and that pin #7 of the socket is not grounded, but returns to the coil tap. This completes the oscillator conversion.

The r.f. input circuit is converted next. The antenna coil L-111 is tapped. It is near the r.f. amplifier tube, V-108. Note where the coil leads go, then re-

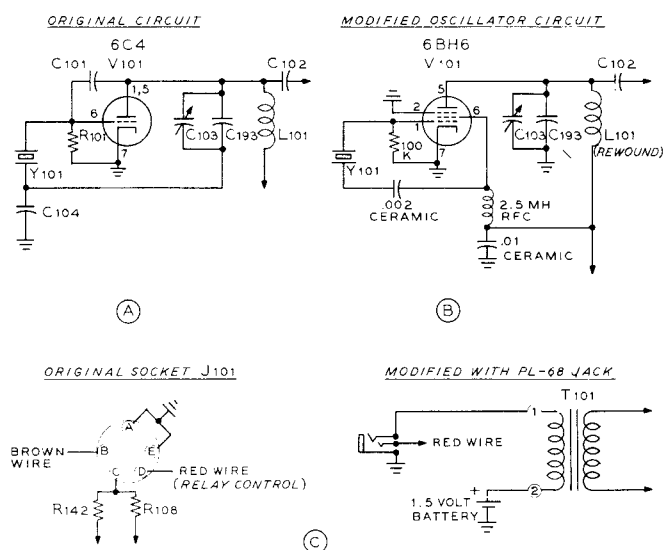


Figure 52

- A—Original MBF transmitter oscillator circuit
 B—Modified oscillator circuit for use with surplus crystals
 C—Replacement of socket J-101 with micro-telephone jack

move the coil. Unsolder the connections carefully, as they must be replaced later. Unwind the 5 turns on the coil, and replace with 7 turns of similar size wire, bend the ends around the eyelets and solder. Leave the hole open in the eyelets. Replace the coil. The bottom terminal goes to pin #1 of socket V-108, and to tuning capacitor C-123 and padding capacitor C-189. The top goes to the other side of the tuning capacitor, and to C-124A, and R-117.

The antenna lead is terminated near the coil at a stand-off insulator. The capacitor (C-168) attached to the insulator now goes to the top of a new two turn coil wrapped over the top turns of coil L-111. Use insulated wire for the new coil, and ground the free end to the chassis next to the coil form. Use a hot iron, and don't damage coil L-111. See figure 51B.

The final modification in the receiver r.f. section is to modify mixer coil L-118-119. Both coils are wound on the same form. Remove the form, remembering where the connections are attached. The coils have 4 turns each. Remove the windings, and rewind with similar size wire, 6 turns each. Replace the coil, and solder all leads.

Other Receiver Modifications 1—The "Press to cut Squelch" switch (S-105) should be changed to a d.p.d.t. toggle switch. The wires to the top two terminals should be interchanged with the wires to the bottom two terminals on the new switch to make the panel markings read right. Be sure not to cross-connect the wires.

2—Remove the two brackets on the panel holding the cover over the receiver tuning capacitors.

3—It is easy to make meter position #1 a "S-meter" for the receiver. Remove the green lead attached to pin #7 and R-144 of socket V-114. Connect this lead to the cathode (pin #2) of the first i.f. tube socket, V-110 through a series resistor of 1K. Shunt cathode resistor R-123 with a 470 ohm, ½-watt resistor (figure 51C).

The receiver chassis is now remounted to the front panel. Remember to replace the phenolic insulator the right way with the bolt holes in the right place. Make sure the front panel mounting screws do not touch the chassis since there is a potential difference between the two.

Testing the Receiver Place a short antenna on the receiver (use J-103), and tune the oscillator tuning capacitor until you hear a station. You can probably hear TV channel 2 or 3 (a strong, a.c. buzz). Peak the other stages by ear. If you hear nothing, check your squelch switch.

Transmitter Modification for 50 Mc. Operation The original MBF circuit uses expensive high frequency crystals. In order to employ the plentiful 6 Mc. type FT-243 crystals, the oscillator circuit must be modified as shown in figure 52. A 6BH6 regenerative oscillator replaces old oscillator tube V-101 (6C4). The new tube has the same filament current as the old for proper series string operation. Terminals #3, 4, and 7 are untouched, and terminal #2 of socket V-101 must be grounded. Terminals #1, 5, and 6 are rewired as shown in figure 52B. Plate coil L-101 tunes to the second harmonic (12 Mc.) of the crystal and is rewound with 26 turns of #26 e. wire. The multiplier stage (V-102) now should tune to the 24–25 Mc. region. Coil L-102 should be altered to 17 turns of #22 e. wire. Space the turns to grid-dip to 25 Mc. The second multiplier tube (V-103) doubles to 50 Mc. Rewind L-103 to 18 turns, center-tapped, #14 e. wire, ½-inch diameter, turns spaced one wire diameter. Adjust spacing to grid-dip the circuit to 51 Mc.

The plate coil of the push-pull 2SD7 is modified to 8 turns, center-tapped, #14 e. wire, one-inch diameter, turns spaced two wire-diameters. Adjust spacing to grid-dip to 51 Mc. The new antenna coil, L-109 is 3 turns, #12 e. wire, one-inch diameter, turns spaced one wire diameter. This completes modification of the r.f. circuitry.

Miscellaneous Transmitter Modifications 1—Change socket J-101 to a PL-68 micro-telephone jack mounted on an insulating plate. Remove the two back wires from terminals #1 and #2 of transformer T-101. Tape each wire. Run a wire from the PL-68 sleeve contact to terminal #1 of T-101, and another wire from terminal #2 of T-101 through 1½-volt flashlight battery to ground. Tape the tube

shield next to the microphone jack to keep it from shortening out (figure 52C).

- 2—Place a 10 μ fd. 25-volt electrolytic capacitor across cathode resistor R-111 (4.7K) of tube socket V-105 (6AQ6). Positive terminal of the capacitor goes to pin #2 of the socket.
- 3—Parallel audio coupling capacitor C-119 with a 0.01 μ fd. ceramic disc capacitor.

Convert Your Surplus 24-Volt Dynamotors to 115 Volt A.C. Motors

You can convert almost any 28-volt dynamotor to a 115-volt motor by the following changes: Remove the brushes from the motor end of the dynamotor. Next, move the two field wires from the motor end to the generator end, and connect them in parallel with the generator field winding. (You have a fifty-fifty chance of guessing the correct polarity of the connections. If the motor does not run, reverse the motor field connections.) Finally, connect a 115-volt line cord across the field coils and generator brushes. You might have to drill and tap the shaft for an extension if it is not long enough to fasten a coupling to it. Your converted motor does not have as much torque as a standard motor, but it may be used for turning fans, grinding wheels, etc.

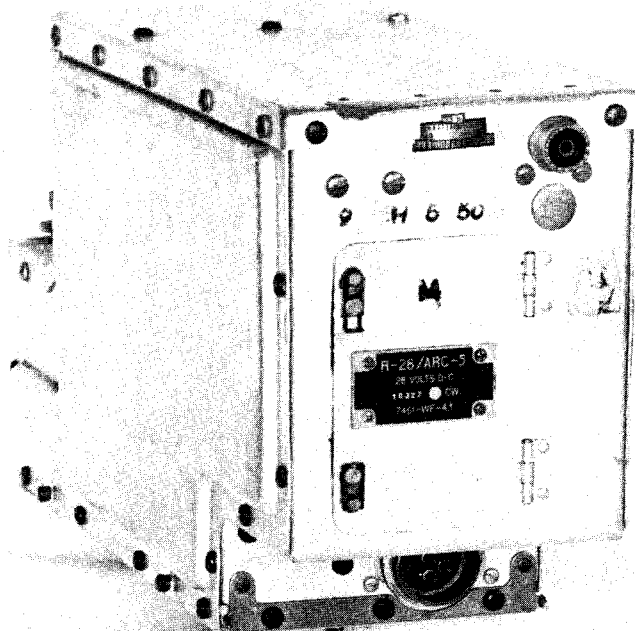
Adding a Tuning Control to the R-28/ARC-5 V.H.F. Receiver

The R-28/ARC-5 receiver is a ten tube superheterodyne covering the frequency range of 100–156 Mc. in

four crystal controlled channels. The receiver requires 24 volts a.c. for the filaments, and 250 volts at 75 ma. plate potential. The complete schematic of the receiver is given in figure 54. It is a very simple matter to change the crystal controlled oscillator to a tunable oscillator for 144 Mc. reception. The receiver can thereby be used for general 2-meter reception.

First, remove the sides and top cover, and the oscillator compartment covers. Locate the crystal oscillator stage, V-108. Connect a 100 μ fd. mica capacitor from the junction of coil L-111 and R-152 to pin #4 (grid) of socket V-108 (12SH7). Install a variable 10 μ fd. tuning capacitor in series with a 3–30 μ fd. zero temperature coefficient ceramic variable capacitor. Ground the rotor of the variable capacitor to the chassis. Connect the free terminal of the ceramic capacitor to pin #8 of socket V-108 (plate). The 3–30 μ fd. capacitor acts as a bandspread capacitor so that the 144 Mc. band can be spread across the full dial of the 10 μ fd. tuning capacitor. When the ceramic capacitor is fully meshed, the tuning range of the receiver is 140–150 Mc. Converted in this manner, the oscillator acts as a tunable oscillator in the region of the original crystal frequency. The succeeding multiplier stages increase this frequency up to the region required for local oscillator injection. Set the receiver to channel B or C for optimum 2-meter reception. The automatic tuning unit may be reworked as described in the section of this book dealing with the T-23/ARC-5 transmitter.

Figure 53
R-28/ARC-5 V.H.F. receiver may be used for 2-meter reception. Receptacle J-103 is at bottom of front panel. Dynamotor space is at rear of receiver deck. Approximate tuning of receiver is indicated by edge-dial at top of panel.



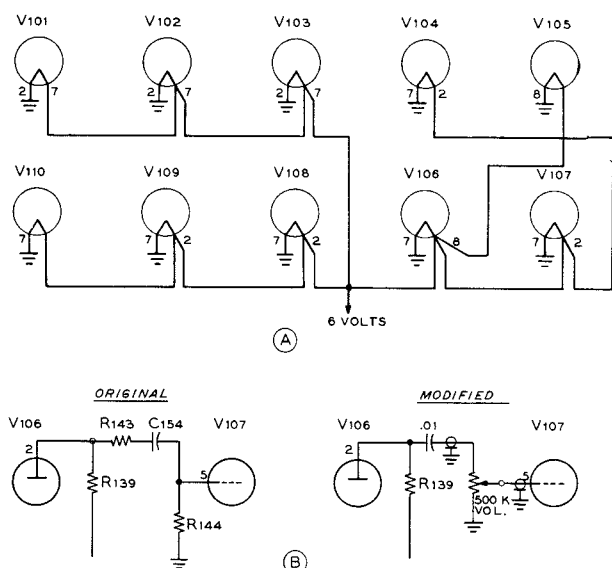


Figure 55

- A—Modified filament circuit for 6 volt operation, R-28/ARC-5
 B—Modified audio circuit

Rewiring the Filament Circuit for Six Volt Operation

A tubes have 6-volt filaments and are not changed. The following wiring changes in the filament circuit are made:

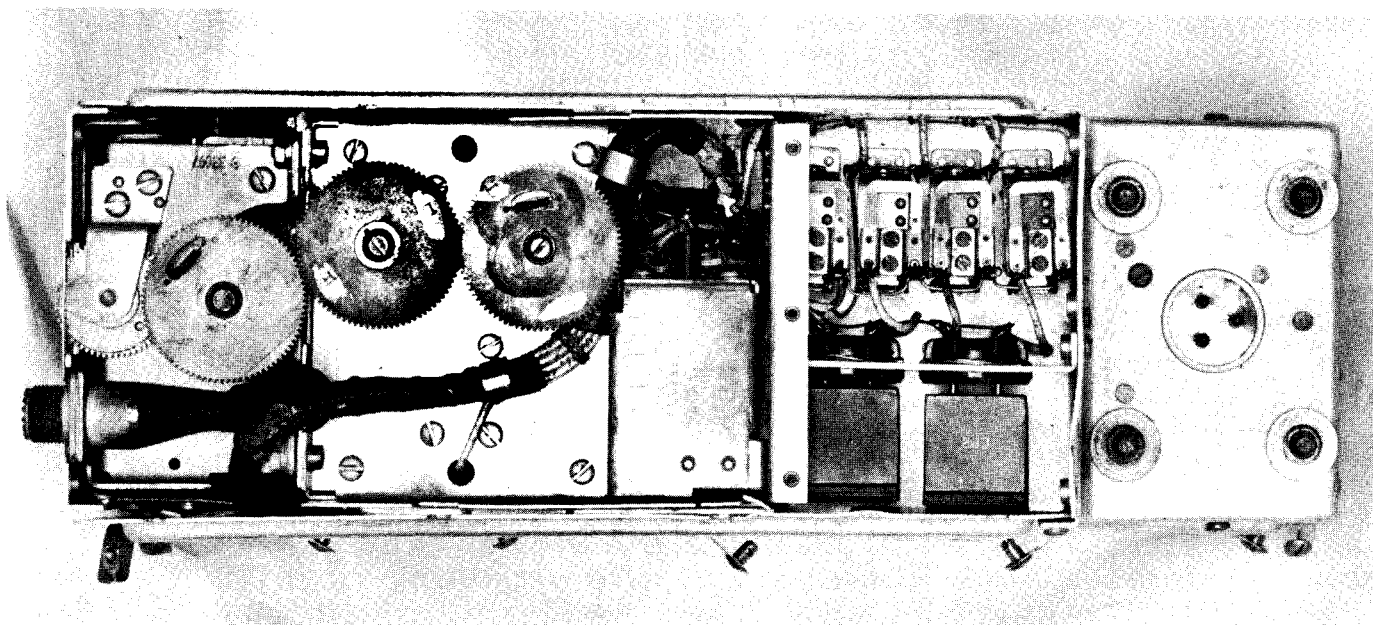
- 1—(Refer to figure 55A). Remove the wire from pin

- #2 of socket V-102 and connect this lead to pin #7 of socket V-102. Ground pin #2 of V-102.
 2—Remove the wire from pin #2 of socket V-103 and connect this lead to pin #7 of socket V-103. Also remove the two 1K resistors connected between pin #2 and pin #7 of V-103. Ground pin #2 of V-103.
 3—Remove the wire from pin #7 of V-109 and connect it to pin #2 of V-109. Ground pin #7 of V-109.
 4—Remove the two 1K resistors between pin #2 and pin #7 of V-108. Remove the wire on pin #7 of V-108 and connect it to pin #2 of V-108. Ground pin #7 of V-108.
 5—Remove the wire on pin #7 of V-107 and connect it to pin #2 of V-107. Ground pin #7 of V-107.
 6—Remove the wire on pin #7 of V-106 and connect it to pin #8 of V-106. Ground pin #7 of V-106. This completes the conversion of the filament circuit for 6-volt operation.

Modifications of Audio Circuits

- 1—Remove R-143 (1 meg.), C-154 (0.006 μ fd.), and R-144 (0.47 meg.) in the grid circuit of the 12A6 (V-107). Replace R-143 and C-154 with a 0.01 μ fd. capacitor. Replace R-144 with a 500K potentiometer. Connect the arm of the potentiometer to pin #5 of V-107. This volume control is mounted on the front panel and leads to it are run in shielded wire. Ground the shields at both ends of the leads.
 2—Remove R-145 (1.5K) from pin #8 of V-107. Re-

Figure 56
 TOP VIEW OF R-28/ARC-5 RECEIVER WITH DUST COVER REMOVED
 Tuning system gear drive is at left, with crystal relays and crystal receptacles at right. Dynamotor mount is at rear of receiver.



place it with a 470 ohm, 1-watt resistor from pin #8 to ground.

- 3—Remove output transformer T-101, capacitor C-157, and limiter R-16B (all in plate circuit of V-107). Replace T-101 with small 5K plate to voice coil output transformer. Connect 0.01 μ fd. ceramic disc capacitor between pin #3 and pin #4 of V-107 socket. The secondary leads of the new transformer connect to your low impedance speaker.
- 4—Connect the rear power plug (J-102) as follows:
 - Pins #1, 3, and 4: B minus, one side of 6-volt fil.
 - Pin #7: B-plus 250 volts.
 - Pin #6: 6 volt filament.
 - Pin #2: Auxiliary audio output.
 - Pin #3: A.v.c. lead. Open connection between pin #3 and pin #1 to disable receiver during transmissions.

Converting the RT-19/ARC-4 Receiver-Transmitter for 2 Meter Operation

The RT-19/ARC-4 is a complete v.h.f. station capable of operation on any one of four crystal controlled frequencies in the 140–148 Mc. range. The transmitter develops approximately 10 watts output over a 1 megacycle bandwidth without retuning. Crystals in

the 5.83–6.0 Mc. frequency range are employed. The complete schematic of the ARC-4 is shown in figure 58.

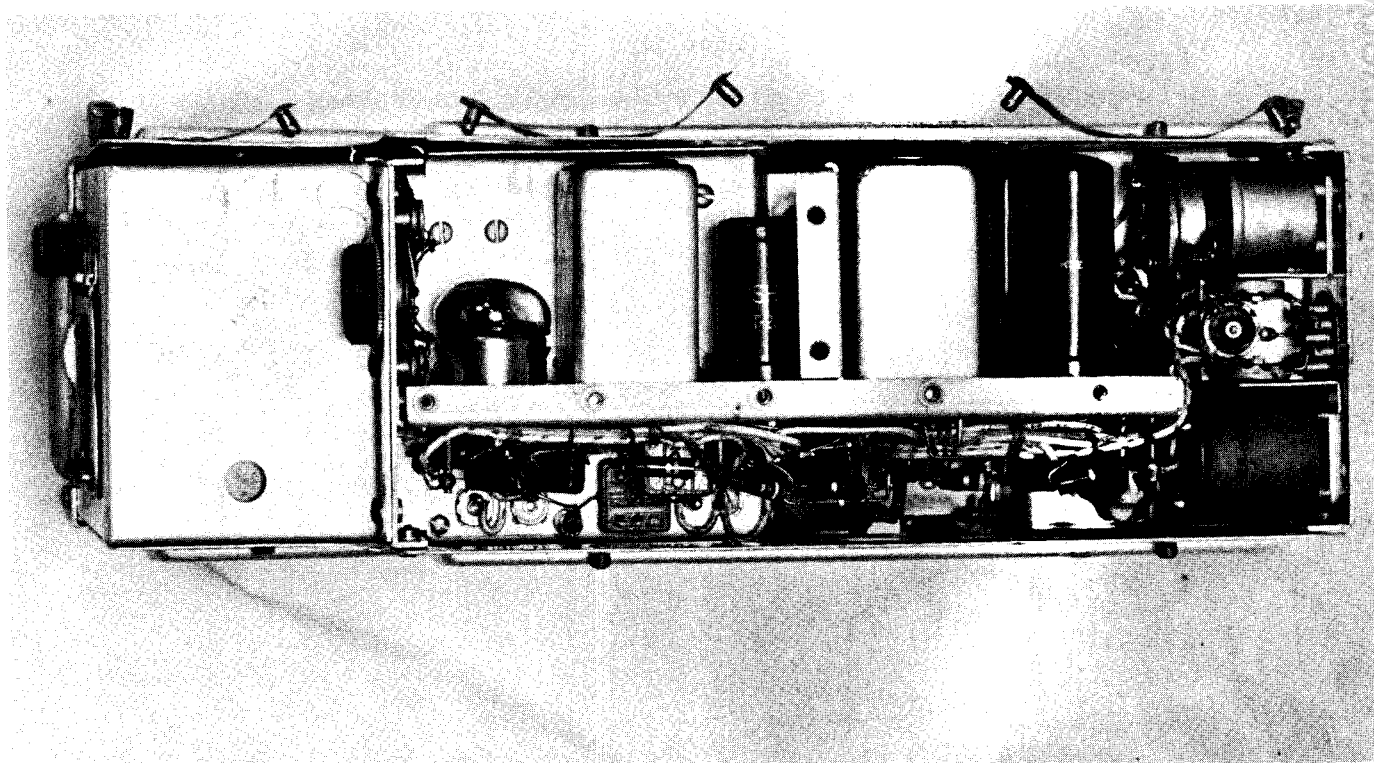
Description of the Transmitter Section

The transmitter of the ARC-4 consists of a crystal-controlled oscillator stage (6 Mc.), followed by three harmonic generators. The oscillator (6V6-GT, V1-T) plate circuit is tuned to approximately 18 Mc. The second 6V6-GT (V2-T) doubles to 36 Mc., and V3-T (1614 or 6L6) doubles to 72 Mc. The final multiplier V4-T (1614 or 6L6) doubles to 144 Mc. The r.f. amplifier (V5-T) is an 832-A, which is plate modulated by two class AB 6L6's (V6-T and V7-T). A carbon microphone is used, and a push-to-talk system is incorporated in the transmitter. The transmitter is designed to be used with a 50–70-ohm coaxial transmission line system.

The Receiver Section

The receiver portion of the ARC-4 employs ten tubes and has two complete r.f. input circuits connected to a common i.f. amplifier. One input circuit ("plane-to-plane") will be removed, and the other one ("plane-to-ground") will be reworked for 2-meter reception, and provided with a tunable oscillator. The "plane-to-

Figure 57
UNDER-CHASSIS VIEW OF R-28/ARC-5 RECEIVER WITH DUST COVER REMOVED
717-A tube is at left, with i.f. stage at center. Power receptacle is at rear of chassis.



ground" section employs a 6AC7 (V3-R) mixer, coupled to three stages of 10 Mc. i.f. amplification (V4-5-6-R) having a passband of about 80 kc. A 12SQ7 (V7-R) is used as an audio squelch tube, and a second 12SQ7 (V8-R) serves as the second detector and audio stage. Two audio output stages employing 12A6 tubes (V9-R and V10-R) are provided. The output of V9-R may be taken from pins 22 and 23 of the plug terminals on the rear of the unit (500 ohm circuit), and the output of V10-R appears at panel jack J1-R and pins #24 and 25 of the same plug.

A 6N7 double triode (V1-R) serves as a conversion crystal oscillator and frequency quadrupler. A second 6N7 (V2-R) acts as a tandem doubler to the v.h.f. conversion frequency.

Power Supply and Control System The ARC-4 is powered from either 12- or 24-volts d.c., and employs either a DY-9/ARC-1 dynamotor (24 volts), or a DY-10/ARC-4 (12/24 volt) dynamotor. Neither dynamotor is required for the following conversion. The ARC-4 is designed to be remotely controlled from the C-51/ARC-4 control box which has a channel selector and audio input and output circuits. The control box is not required for the conversion.

Transmitter Conversion Crystals of the surplus FT-243 type are used in this conversion. The two-meter band requires crystals in the range of 6.0 Mc. to 6.16 Mc. For the Novice band, crystals ranging from 6.045 Mc. to 6.125 Mc. should be employed. To make these crystals operate properly, two capacitors in the oscillator circuit must be changed. Remove C2-T (50 μ fd.) (between pin #5 and pin #8) on socket V1-T and replace with a 15 μ fd. mica capacitor. Next, remove capacitor C3-T (400 μ fd.) across oscillator coil L1-T and replace with a 100 μ fd. mica capacitor.

Microphone Voltage for Transmitter At the rear of the chassis on the transmitter side are two resistors: R3-C (30 ohms, marked Z30 W-L.), and R32-T (200 ohms, marked Z200). Remove R3-C from the chassis and disconnect the white wire with red-yellow tracer connected to the junction of the two resistors. Ground the end of R32-T that was connected to this wire. Terminals #19 and 7 on the rear chassis plug are connected together to complete the circuit of R26-T and R32-T. This places R32-T in series with R26-T, which is the modulator cathode bias resistor. Next, the lead of R29-T is disconnected from the filament circuit and attached to the terminal of R32-T (figure 60A). Both terminals of R29-T are bypassed to ground with 50 μ fd., 50 volt electrolytic filter capacitors.

Receiver Audio Modifications A portion of the audio signal voltage from the microphone is fed to the receiver audio section for the intercom circuit. Disconnect the bare wire lead from the grid (pin #5) of 6L6 tube socket V7-T that runs to the terminal board adjacent to the tube, and connects to resistor R28-T (250K). Now disconnect the white wire with green tracer on the grid (pin #5) of 12A6 tube socket V10-R. Disconnect the white wire with red-brown tracer that connects to the junction of R47-1R and R47-2R (10,000 ohms), which is mounted on the receiver side of the chassis. Now, connect a wire from this center tap junction to the end of R42-R (1500 ohms) located on the side at the rear of the chassis. The correct terminal is the one nearest the rear. This removes the B-plus from the receiver audio stages when transmitting.

Relay Circuit Modifications A Sarkes-Tarzian M-500 silicon rectifier is used in the circuit of figure 60B to rectify the filament voltage for operation of relay S5-C. The rectifier and filter capacitor are mounted near the crystal sockets. The two leads (white with blue-green tracer) that were formerly connected to R3-C (30 ohms) are attached to the positive terminal of the rectifier. The negative terminal of the rectifier is attached to the 12.6-volt filament line through a 100 ohm resistor. A 500 μ fd., 25 volt electrolytic capacitor is placed between the positive terminal of the rectifier and ground as shown in the schematic drawing. Finally, remove the crystal switching relays.

Filament Circuit Modifications To operate the filaments from the power supply, strap the following terminals on the rear power receptacle plug in groups, as follows: Group 1: 1 and 2. Group 2: 5, 6, 15 and 16. Group 3: 3, 4 and 19. Group 4: 28 and 18. Group 5: 8 and A1. Connect a 30K, 1-watt resistor from pin #18 to A1. Filament voltage is applied to pins A1 and A2 (ground), as shown in the power supply schematic (figure 65).

Receiver Modifications Remove the "plane-to-plane" channel tuning unit located in the center of the chassis by unscrewing the four 10-32 machine screws beneath the chassis. Remove the top cover plate of the first i.f. transformer FL1-R and loosen the screw inside that holds the coaxial line entering the top of the transformer. Pull up on the tuning unit and it will come free. Take the sides off the tuning unit and remove the 6N7 oscillator plate coil L5-R. This coil may be identified by the great number of turns on it. Also remove one of the 50 μ fd. ceramic capacitors in the unit. It will be needed later, along with the coil. Finally, remove the plate holding the auxiliary capacitors of the tuning unit from the back of the ARC-4 panel.

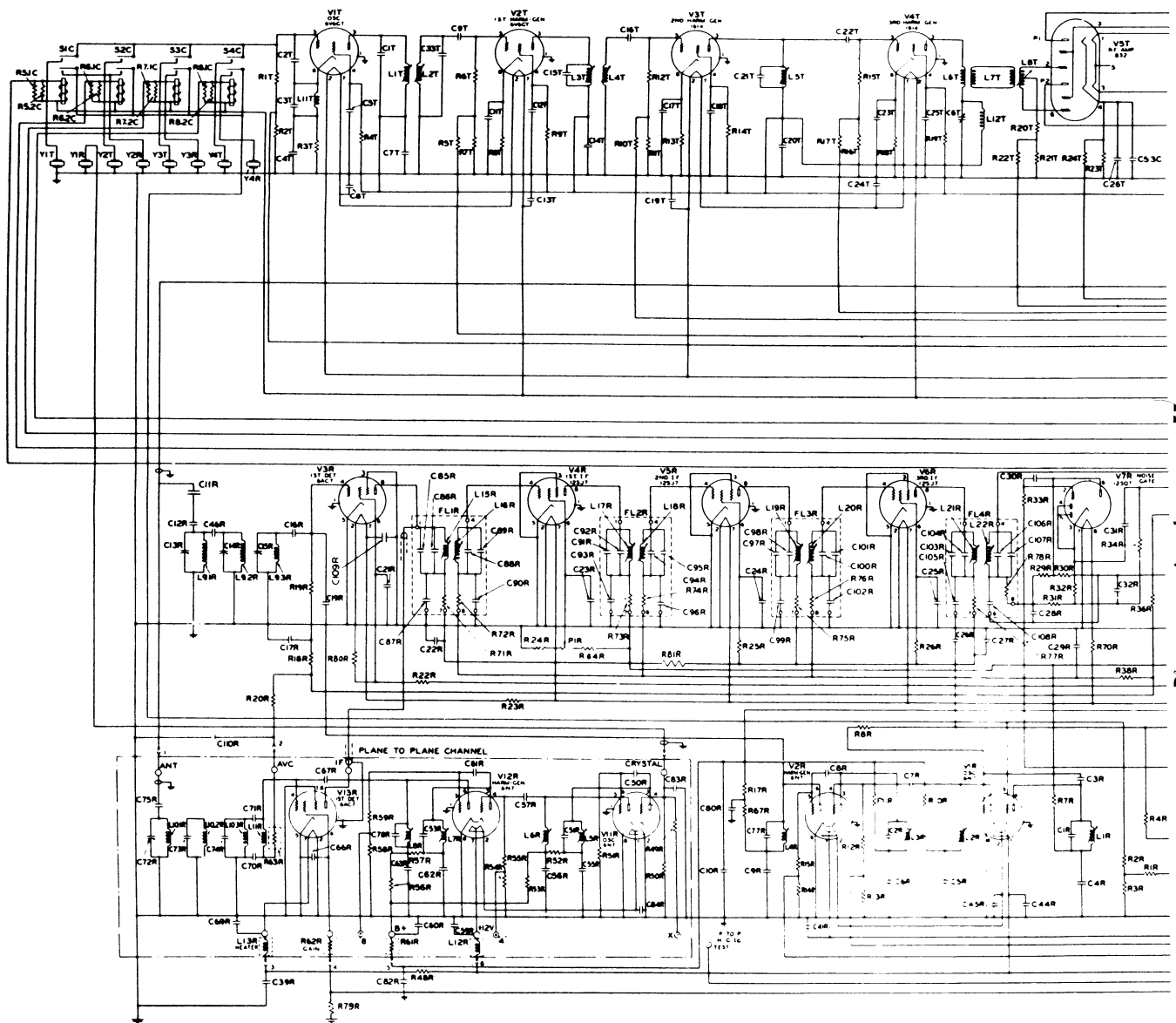


Figure 58
SCHEMATIC, RT-19/ARC-4

Diagram continued from page 54

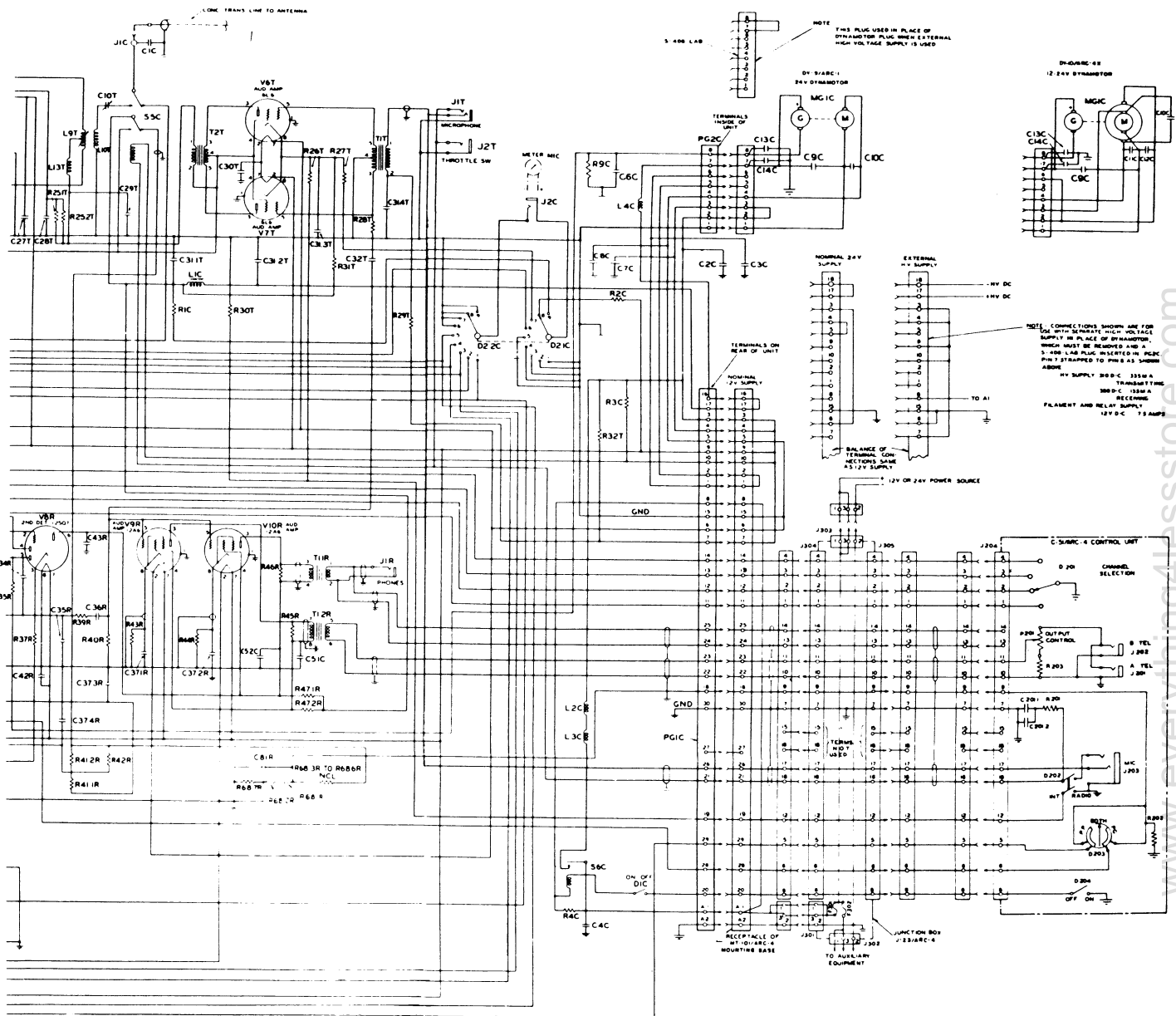


Figure 58
SCHEMATIC, RT-19/ARC-4



Figure 59
PANEL LAYOUT
OF CONVERTED
ARC-4, SHOWING
PLACEMENT OF
MAJOR CONTROLS
0-1 d.c. milliammeter and selector switch are at left of tuning dial. Type FT-243 crystal mounts in holder beneath dial. Pilot lamp, a.c. switch and i.f. gain control are above dial.

Coil L5-R is now mounted on the ARC-4 chassis, about 6½" behind the front panel, and positioned as shown in figure 61. The bottom end of the winding is grounded, and a 20 μ fd. ceramic capacitor is connected across the winding. Connect the coil to a 50 μ fd. ceramic capacitor which goes to the bottom end terminal on the nearby phenolic strip as shown in figure 62. This coil converts the oscillator from crystal control to a tuned-plate tuned-grid circuit (figure 60 C).

A clearance hole is now drilled through the chassis near the second bottom terminal of the phenolic strip, and a small ceramic feed-thru insulator is placed in the chassis hole. The terminal of the insulator is connected to pin #6 (plate) of the 6N7 socket V1-R, behind the phenolic strip.

About this stage of the game, a new panel plate should be cut and mounted in position on the front of the ARC-4. Position of the main controls can be seen

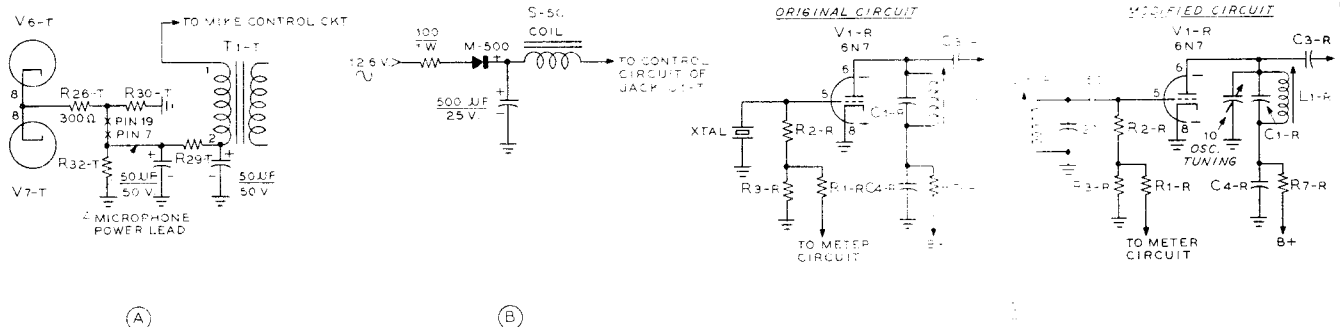


Figure 60

- A—Microphone circuit of ARC-4. The microphone power lead to R32-T may be removed and attached to cathode pin #8 of socket V6-T to raise modulation level if a low output carbon microphone (T-17 type) is employed.
- B—Rectifier system for relay control.
- C—Revised receiver oscillator circuit. The 10 μ fd. capacitor is tuned from the front panel, as shown in figures 63 and 59.

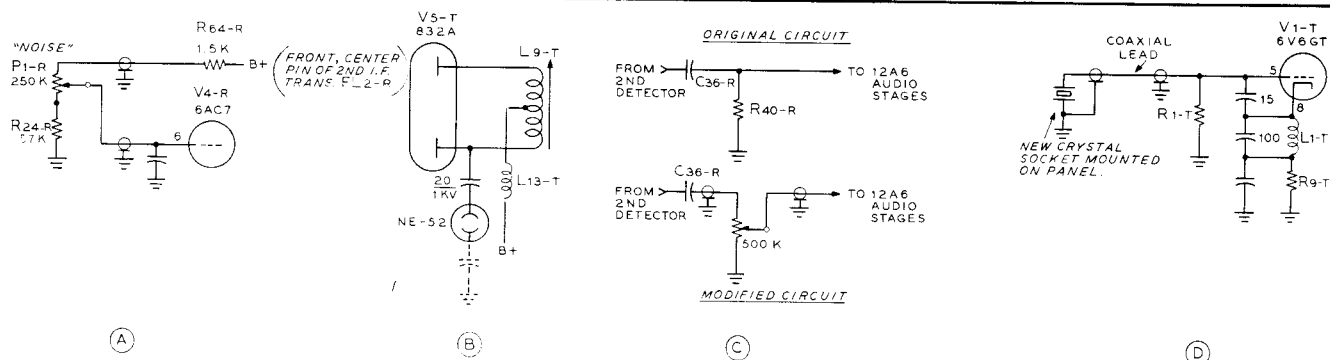
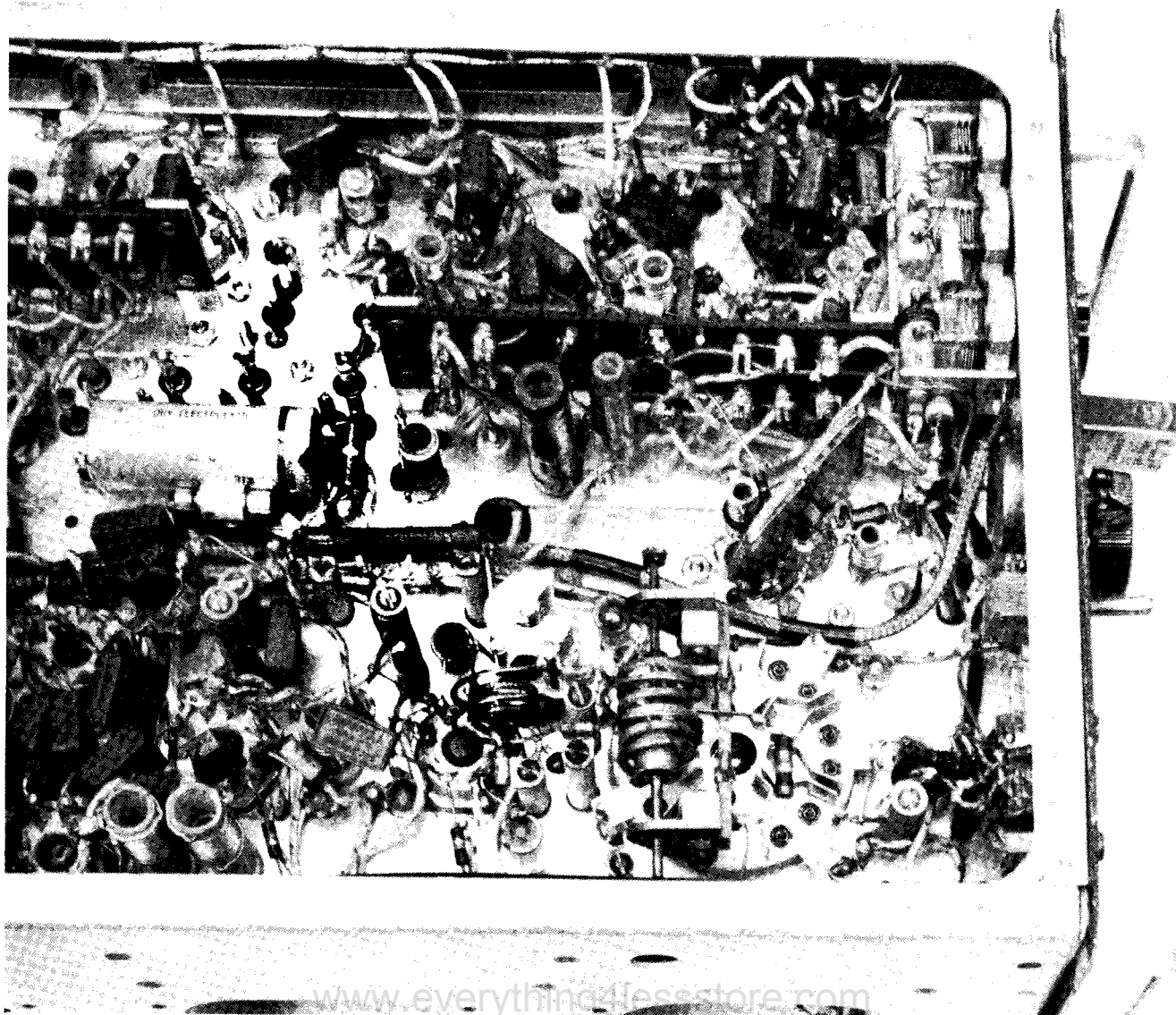


Figure 62

- A—I.f. gain control (labeled "noise") for ARC-4
 B—Small neon tube makes inexpensive modulation indicator. Neon lamp is mounted in rubber grommet in panel. Capacitance to ground of shell permits bulb to light (see dotted line).
 C—Modified volume control circuit for ARC-4
 D—Coaxial lead for transmitter crystal socket (see figure 61).

Figure 61

UNDER-CHASSIS VIEW OF ARC-4 SHOWING CASCODE R.F. AMPLIFIER (RIGHT) AND MODIFIED RECEIVER OSCILLATOR. Coaxial lead to panel crystal holder passes along center of chassis. Silicon power supply for change-over relay is at left.



left is the meter selector switch, receiver tuning control, and modulation indicator (figure 62B). The transmitter amplifier tuning control is at the far right. Receiver adjustment controls, transmitter crystal socket, transmit switch, and phones and microphone jack are placed at the bottom panel edge.

The 500K volume control has one terminal grounded. Remove the wire connecting the grid of 12A6 socket V59-R to resistor R40-R (100K) which is the second resistor from the end of the terminal board located near the four relays beneath the chassis. Connect a wire from the grid of tube VS9-R to the center arm of the volume control (use shielded wire). Connect a wire from the remaining terminal of the volume control to resistor R40-R at the terminal where the wire was previously removed (use shielded wire). Remove resistor R40-R by clipping the leads.

A short length of RG-59/U coaxial cable is used to connect the crystal socket to the oscillator tube, as shown in figure 62D. The shield is grounded to the chassis at both ends of the conductor.

A Cascode Amplifier for the Receiver

The sensitivity of the ARC-4 receiver leaves much to be desired if stations beyond the line of sight are to be worked. A simple 6BQ7-A cascode amplifier may be built into the receiver section that will greatly enhance the performance. The placement of the amplifier can be seen in figure 61. A small copper shield plate is mounted across the 6BQ7-A socket, and is grounded to pins #4 and 9 and the center stud of the socket. The neutralizing coil L-3 passes through a $\frac{1}{4}$ -inch hole drilled in the

shield. Coils L-1 and L-2 are mounted on either side of the shield plate. The cascode schematic is shown in figure 64.

The Power Supply The power supply is placed in the rear chassis area, as shown in figure 66. The wiring of the supply is shown in figure 65. To balance the filament drain, the 6BQ7-A and the pilot lamp are wired as shown in the schematic. All other filaments are wired correctly when the rear power connector terminals are strapped as previously described. It is necessary to insert a 750-ohm, 20-watt resistor in series with the *receiver B-plus* terminals of relay S5-C to hold the receiver voltage to 300.

Alignment of the ARC-4

The first step is to align the receiver oscillator. The slug of the oscillator grid coil (L5-R) is adjusted to resonate the circuit to 8550 kc. (use a grid-dip oscillator). The plate coil slug (L1-R) should be adjusted so the receiver tuning capacitor tunes the range 8.5 Mc. to 8.8 Mc. Set the oscillator to approximately 8.65 Mc. and tune the harmonic generator circuits for maximum meter reading as shown in figure 67. The slugs in these circuits are set very close to the correct adjustment when you receive the ARC-4, so do not alter the setting too much! With an antenna on the receiver, you should now start to hear two-meter signals. Adjust the three r.f. trimmers (lower left corner of the panel) from left to right for maximum signal strength. One adjustment will hold over a tuning range of about one megacycle. Finally adjust

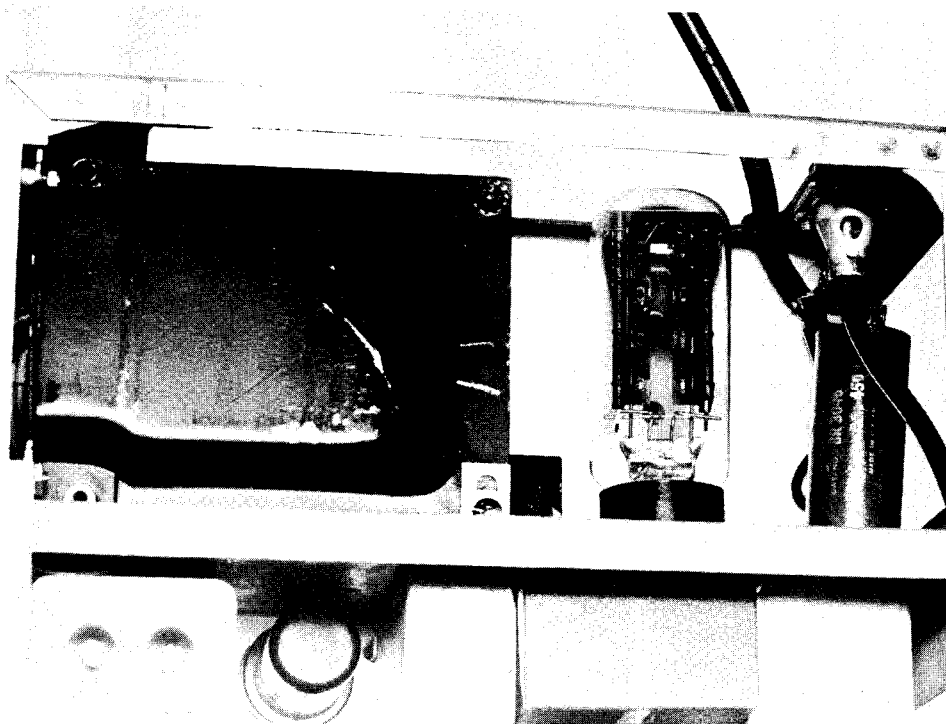


Figure 66
POWER SUPPLY IS
INSTALLED IN
DYNAMOTOR AREA
OF ARC-4

Transformer is at left, with filter capacitor to right of tube. Extra 20 μ fd., 450 volt capacitor is added to output of supply to reduce hum. Small aluminum box is placed over rear of rectifier tube socket to prevent danger of shock from terminals.

RECEIVER TUNING CHART		
METER POSITION	TUNING ADJUSTMENT (TUNE FOR MAX. READING)	METER READING (0-1 MA.)
OSC. GRID	L1-R	0.2-0.6
2ND MULT. GRID	L2-R	0.1-0.14
3RD MULT. GRID	L3-R	0.08-0.1
A.V.C.	L4-R	MEASURE WITH VTVM ON A.V.C. BUSS
TRANSMITTER TUNING CHART		
METER POSITION	TUNING ADJUSTMENT (TUNE FOR MAX. READING)	METER READING (0-1 MA.)
OSC. GRID	—	0.2
1ST MULT. GRID	L1-T — L2-T	0.3-0.5
2ND MULT. GRID	L3-T — L4-T	0.3-0.5
3RD MULT. GRID	L5-T	0.3-0.5
R.F. AMP. GRID	C6-T	0.25
R.F. AMP. GRID	L8-T	0.25
R.F. AMP. PLATE	L9-T (MIN. READING)	0.5

Figure 67
METER CHART FOR TUNING RT-19/ARC-4

the slugs of cascode coils L-1 and L-2 for best signal reception.

The crystal is now plugged in the transmitter and the multiplier circuits are tuned for maximum meter current, as indicated in figure 67. Load the antenna by increasing the loading capacitor (C10-T) and then tune the r.f. amplifier stage for minimum dip. Repeat until maximum loading is obtained while still observing a plate current dip.

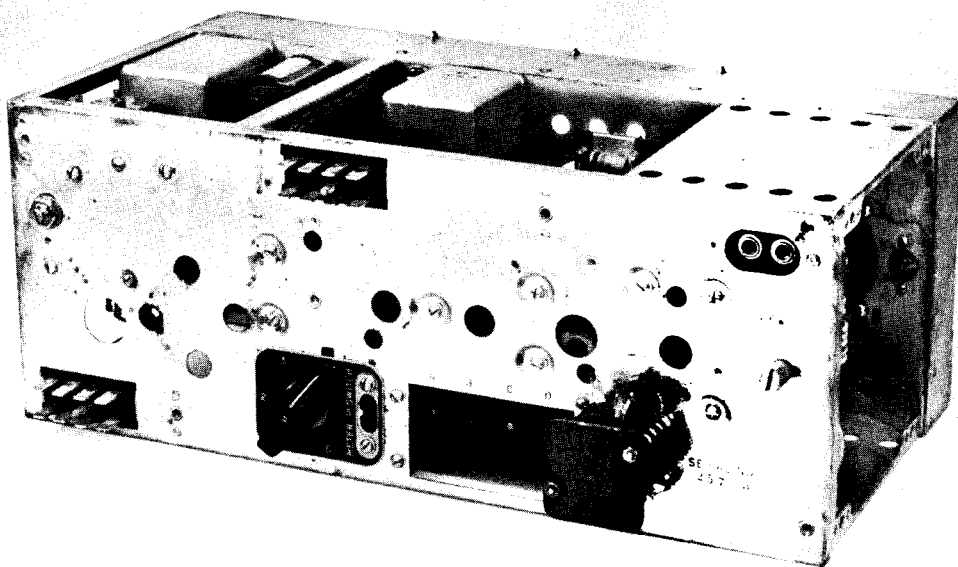
Modern, TVI-Proof Conversion of the SCR-522 Transmitter

Many conversions have been shown for the BC-624 transmitter portion of the SCR-522 v.h.f. receiver-transmitter. The conversion described in this section is recommended for two and six meters, as it eliminates the t.v.i. difficulties normally encountered with this equipment. The unconverted transmitter is shown in figure 68.

First of all, remove the transmitter from the cabinet and strip off unnecessary components, such as the tuning slides, etc. Move the power connector to the rear of the chassis as shown in figure 69A. Make up a power cable as shown in figure 69B, using #14 wire for the filament leads, as shown. Next, mount a SO-239 coaxial connector near the tripler stage, as shown in figure 69C, and run a coaxial lead from the connector to the antenna link of the transmitter.

If a carbon microphone is used, it is necessary to install four "pen-lite" batteries in series with the primary winding of the microphone transformer. Better still, a crystal microphone can be employed with the transmitter if the simple transistorized speech amplifier shown in figure 70 is installed in the transmitter. It is recommended over vacuum tube amplifiers since there is less danger of audio feedback. A 1N34 diode rectifies the filament voltage to deliver a small negative potential suitable for the transistor. Remove the microphone transformer and connect the output of the transistor amplifier to the "hot" terminal of volume control #125.

Figure 68
THE
UNMODIFIED
BC-624
TRANSMITTER
SECTION OF
THE SCR-522
V.H.F.
TRANSMITTER-
RECEIVER



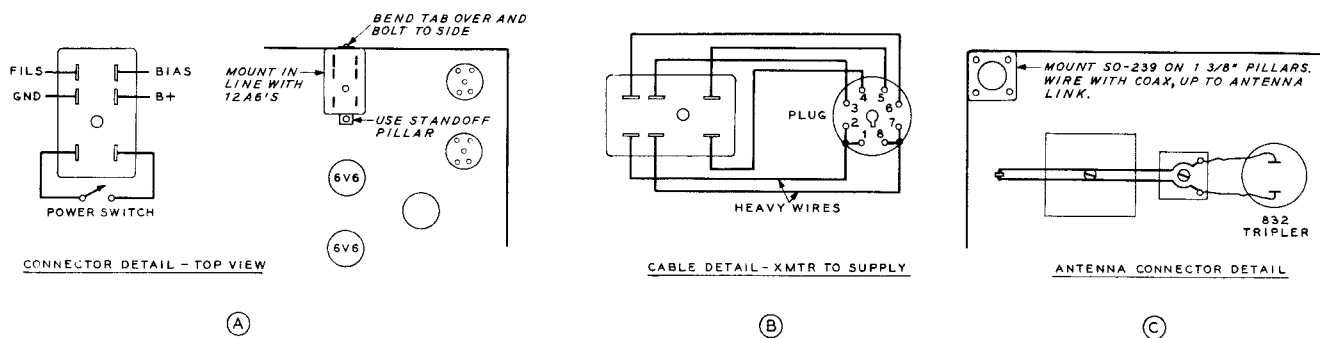


Figure 69

- A—Power plug modification for 522 transmitter, for use with a.c. supply shown in figure 75.
 B—Connecting cable between transmitter and power supply.
 C—New coaxial antenna receptacle is mounted in corner of transmitter chassis near 832-A tripler stage.

T.V.I.-Proofing the Transmitter

Install a 0.001 μ fd. disc ceramic capacitor across the filament pins of each tube socket. Bypass all leads on the power connector with 0.001 μ fd. disc ceramic capacitors. In addition, bypass each meter lead with 1.5 KV, 0.001 μ fd. disc ceramic capacitors. Use a meter with a metal case, or else cut a section of a tin can to cover the rear of the meter if a phenolic-cased meter is used. Ground the can to the transmitter panel, permitting the meter terminals to pass through holes cut in the rear disc of the can.

To shield the transmitter completely, it may be mounted in the metal case from a BC-375 tuning unit. Small, $\frac{1}{8}$ -inch holes should be drilled in the case to aid ventilation. The completed transmitter, mounted on a relay rack panel is shown in figure 71.

Circuit Modifications The braid straps that connect the plate terminals of the 832-A tubes to the tank circuits should be removed and replaced with copper strap. The braid gets warm during operation of the transmitter because of the

high r.f. resistance. Transmitter output increases when the braid leads are replaced. Modulation is also improved when the 12A6 audio tubes are replaced with 12V6-GT's. No wiring changes are necessary.

A crystal-v.f.o. selector switch that may be incorporated in the transmitter oscillator circuit is shown in figure 72.

To operate the 522 transmitter on six meters, the following coil changes are necessary: Replace the tripler (first 832-A) plate coil with a new inductance consisting of 14 turns of #14 enamel wire, $\frac{5}{8}$ " diameter, and about $1\frac{1}{2}$ " long. The B-plus lead is attached to the center of the coil. The antenna coil consists of 5 turns of #14 insulated wire wound over the center of the plate coil. The tripler stage now acts as a six-

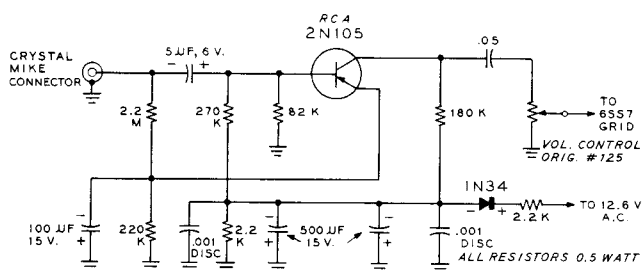


Figure 70

SIMPLE TRANSISTOR SPEECH AMPLIFIER PERMITS USE OF CRYSTAL MICROPHONE WITH SCR-522 TRANSMITTER

Small amplifier may be mounted between volume control and the microphone jack on the inside of the chassis.

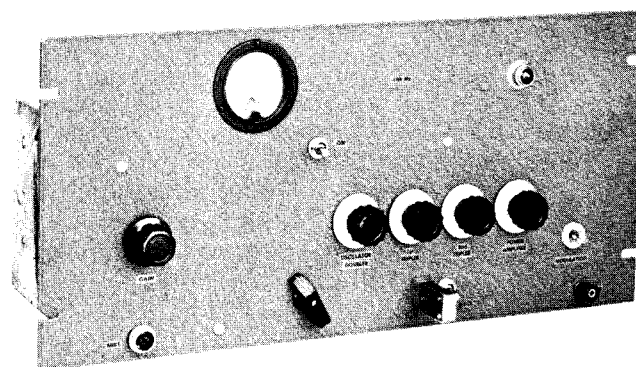


Figure 71

MODIFIED 522 TRANSMITTER IS MOUNTED ON RELAY RACK PANEL
 Case from BC-375 tuning unit is slipped over chassis to complete anti-T.V.I. shielding. Additional conversion information is given in Vol. I of the "Surplus Radio Conversion Manual."

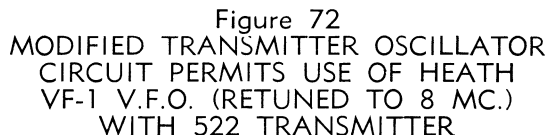
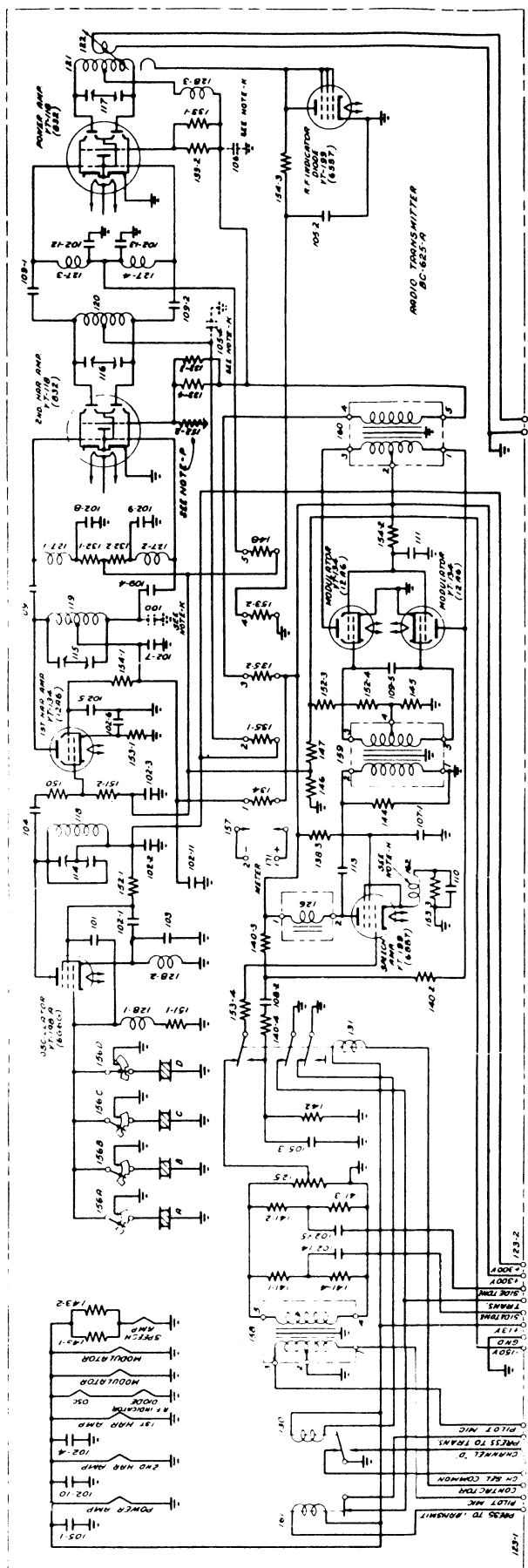


Figure 75 is a schematic diagram of a power supply for a vacuum tube radio receiver. The circuit includes a 115V AC input, a 3 AMP AGC3 FUSE, and two power transformers, T1 and T2. Transformer T1 has a primary with GREY and BRN leads, and a secondary with RED, YEL, GRN, and BRN leads. Transformer T2 has a primary with RED-YEL and GRN leads, and a secondary with GRN leads. The secondary of T1 is connected to a 5U4GB vacuum tube rectifier. The secondary of T2 is connected to a 50 MA. SELENIUM RECTIFIER. The output of the 5U4GB rectifier is connected to a CH1 capacitor (20UF, 450 V.) and a 50 K 25 W resistor. The output of the selenium rectifier is connected to a 1K, 0.5 W. resistor. The circuit is powered by a 12.6 V.A.C. source and a -140 V. source. The output is connected to a SOCKET 8-PIN (AMPHENOL) with pins 1 through 8 labeled.

Transformer T-1 delivers 325-0-325 volts at 255 ma., C.C.S., 5 volts at 3 amperes, and 12.6 volts at 5.3 amperes. Transformer T-2 delivers 125 volts at 50 milliamperes. Choke CH-1 is 4 henries at 250 ma.



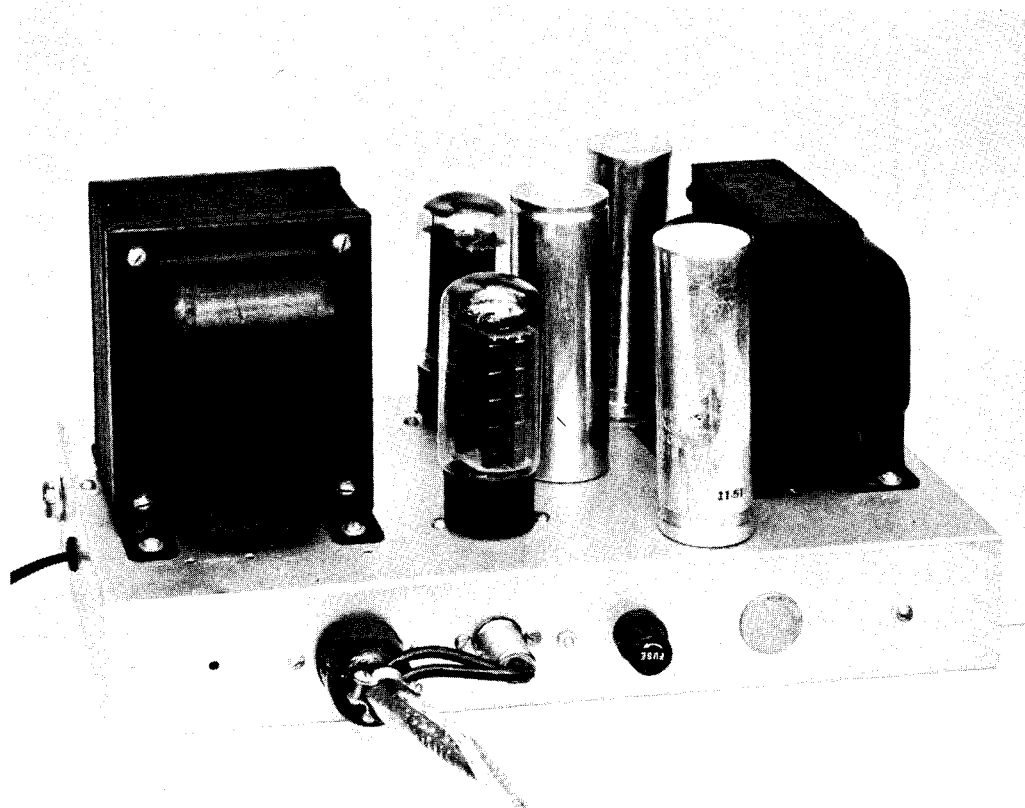


Figure 74
POWER SUPPLY
FOR SCR-522
TRANSMITTER
IS ASSEMBLED
ON AUXILIARY
CHASSES

See figure 75 for
schematic

The BC-312 and BC-342 Series Receivers

The BC-312 and BC-342 series receivers are, without modification, acceptable communications receivers. However, their performance can be greatly improved for amateur communication work by making certain modifications in various portions of the receiver. Any one of the changes or all the changes may be made, each change adding a certain amount to the performance and flexibility of the receivers. The various changes will be treated separately so that any one or all the changes may be made at the discretion of the owner of the receiver.

Power Supply for the BC-312

If the receiver is a BC-312, a power supply must first be constructed. The BC-342 is equipped with an integral 115-volt power supply but the BC-312 has a 12-volt dynamotor in place of the a.c. power supply of the BC-342. Otherwise the receivers are substantially identical. It will be assumed throughout this and subsequent discussions that the owner of the receiver has a copy of TM 11-850 or one of the other instruction books on this series of receiver since these instruction books were furnished with the receivers or were generally available at the time the receivers were sold.

The Dynamotor must first be swung out on its hinges, and then the leads from the dynamotor to the 9-terminal connection strip removed. A power supply such as shown in Figure 77 and diagrammed in Figure

79 must then be constructed. The one illustrated employs a Signal Corps C-228 power transformer, which is the same one as was used in the RA-20 power supply for the BC-342. A large number of these power transformers have been available, but if one cannot be obtained, any power transformer having a 650-volt to 750-volt center-tapped high-voltage winding, a 5-volt filament winding for the 5Y3-GT, and one or two 6.3-volt filament windings at 1.75 amperes or greater will be satisfactory. If the transformer has two 6.3-volt filament windings (such as the UTC type R-12) they are connected in series to obtain the 12.6 volts necessary for heater operation of the receiver. If the transformer has only one 6.3-volt winding an additional very small 6.3-volt 2-ampere filament transformer must be placed in the power supply and connected in series with the 6.3-volt winding on the main power transformer to obtain the 12.6 volts. The junction between the two 6.3-volt filament windings should be grounded in the power supply.

One complication is introduced by the fact that the dial-lamp circuit uses two 6.3-volt lamps in series to ground, so that if the lead to the dial lamps is connected to either of the hot 6.3-volt filament leads the lamps will only receive half voltage. This may be satisfactory, since the lamps give adequate light at this voltage, or the two lamps may be connected in parallel by removing the bezel that covers the two lamps and rewiring them.

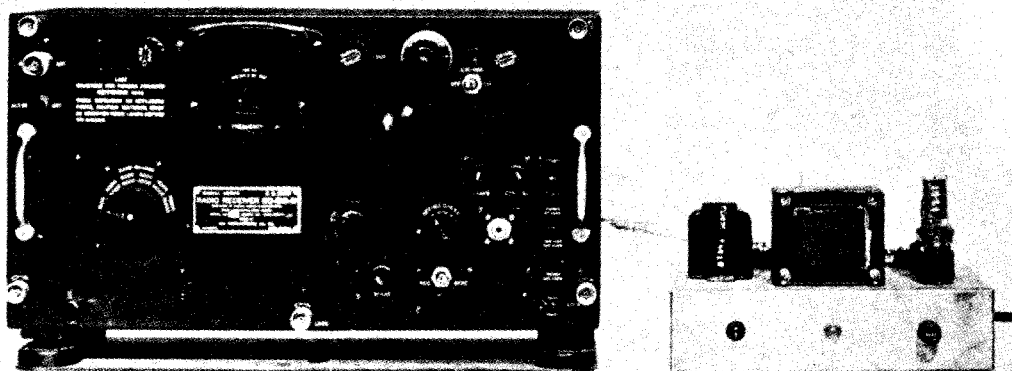


Figure 77.

FRONT VIEW OF THE CONVERTED BC-312 RECEIVER WITH THE POWER SUPPLY ALONGSIDE.

The coaxial i.f. energy output fitting can be seen on the panel in the position formerly occupied by the power connector. The switch mounted at the bottom of the vertical row of jacks is the noise-limiter on-off switch. The power supply is normally mounted remotely from the receiver and controlled by the OFF-MVC-AVC switch.

The balance of the power supply is quite conventional. The VR tube shown in Figure 79 need not be used unless desired, but its use does afford improved oscillator stability.

Voltage Regulation for H.F. Oscillator

The high-frequency oscillator used in the receiver is quite stable, but when operating on the 14-Mc. band there is some variation in the tone of a c.w. signal when the r.f. gain is varied, or when the line voltage varies as a result of a household refrigerator turning on or off or from some similar cause. This condition is cured by using voltage regulation on the plate supply voltage to the high-frequency oscillator. The incorporation of voltage regulation on the oscillator requires that a lead be brought out of the oscillator compartment for separate plate-voltage feed to the tube. This operation requires removal of the cover from the oscillator compartment, and the removal of 30,000-ohm resistor R_{41} . This resistor is replaced by a 1000-ohm $\frac{1}{2}$ -watt carbon resistor. The r.f. stage chassis is then lifted back, after removing the leads to the tube caps, and the plate-voltage terminal coming out of the oscillator compartment is by-passed with a 0.002- μ fd. postage-stamp mica capacitor which can be placed flat against the chassis below the terminal strip. The lead for plate voltage to the oscillator is then brought under the r.f. chassis and down through the hole where the other leads feeding the r.f. chassis pass. This plate-voltage lead then goes, of course, to the plate of the VR-105.

R.F. Changes The r.f. system in the standard receiver is slightly lacking in gain and signal-to-noise ratio on the highest frequency range. This condition can be checked by removing the antenna lead from the receiver, turning the receiver wide open on MVC, and then rotating the trimmer APC on

the first r.f. stage through resonance. Only a very slight increase in noise level will be noticed when this trimmer passes through resonance.

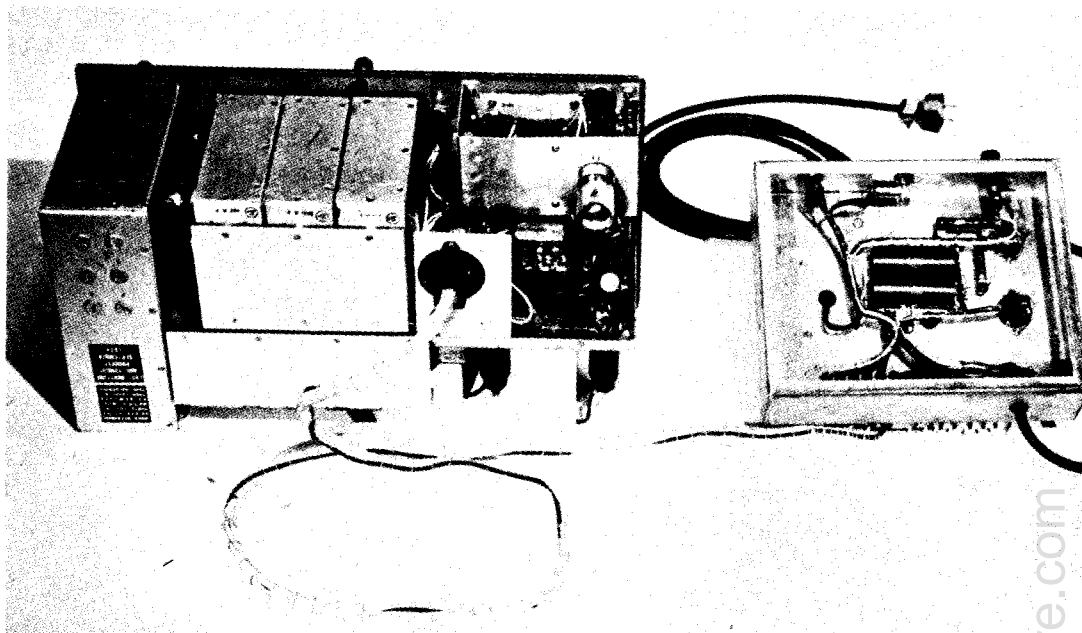
The most satisfactory way of correcting this condition (and this method was proven best after trying a number of other expedients) is to replace the 6K7 first r.f. stage with a 6SH7. It so happens that the receiver is laid out in such a manner that a single-ended tube in the first r.f. stage gives much more direct leads than the double-ended tube originally used. The procedure is as follows:

Remove the tubes from the r.f. chassis and invert the chassis as far as possible. Remove the leads from pins 3, 4, 5, 6, and 8 of the tube socket for the first r.f. stage. Remove the old cathode-bias resistor RS-164. Run a 100-ohm 1-watt resistor from the small micarta terminal block for the MVC lead to pin 5, and also run to pin 5 a lead from the cathode by-pass section of the capacitor block for the stage. Install an additional 0.002- μ fd. postage-stamp mica capacitor as a cathode-by-pass from terminal 3 to terminal 1. Separate the screen-voltage lead that went to terminal 4, shorten it until it fits more neatly and solder to pin 6. Now run the plate lead for the tube, which did go to terminal 3 and run it *under* all the wires near the heater end of the socket and connect this lead to terminal 8. Remove the lead which went to the grid cap of the 6K7, solder a wire about 1½ inches long to this terminal on the main chassis, push the sub-chassis down as far as it can go and still reach terminal 4 on the tube socket with a soldering iron, and solder this new lead to terminal 4. Then push the chassis back into place gently, at the same time making sure that the grid lead to the tube (terminal 4) keeps free of the chassis and bends out toward the ganged tuning capacitor.

It will now be necessary to re-align the r.f. stages of the receiver slightly (*not* the h.f. oscillator how-

Figure 78.
UNDERCHASSIS VIEW OF THE
RECEIVER AND POWER
SUPPLY.

The bent-aluminum chassis holding the 7A6 noise limiter tube can be seen behind the power-cable receptacle. The added chassis is mounted to the front panel.



ever). Peak up the 6L7 mixer stage first, then the second r.f. stage, and then the first r.f. stage. The gain will be found to be much greater than before, and the increase in noise when the first r.f. stage is trimmed through resonance will be found to be very pronounced. If a tendency toward instability is encountered near maximum gain on MVC, re-trim the *mixer* stage padders slightly until the instability disappears.

All these receivers have a certain amount of backlash in the vernier tuning control. In several receivers the amount of backlash has been reduced to a very small amount by carefully lubricating all the gears with a small amount of vaseline, using a toothpick or a matchstick to apply the lubricant. Then the backlash, which in the receivers mentioned was caused by axial motion of the tuning-capacitor gang, can be substantially eliminated by careful adjustment of the ball thrust bearing at the *oscillator* end of the tuning gang. This bearing is inside the oscillator compartment.

I.F. Amplifier Changes

The i.f. amplifier operates quite satisfactorily, but the action of the crystal filter leaves much to be desired. The reduction in set gain when the crystal filter is switched into operation can be greatly reduced by the following procedure: Remove the cover from the crystal-filter transformer. Scrape the stud which serves as a stop for the rotation of the crystal-phasing capacitor and solder a very small wire to this stud and to the small switch contact on the other side of the phasing capacitor. Then turn the phasing control until the moving contact rests firmly against the stud. Re-install the cover of the transformer and align the slug which comes out of the *top* of the crystal-filter transformer for maximum noise with the antenna removed from the receiver. This position of the control (180° from

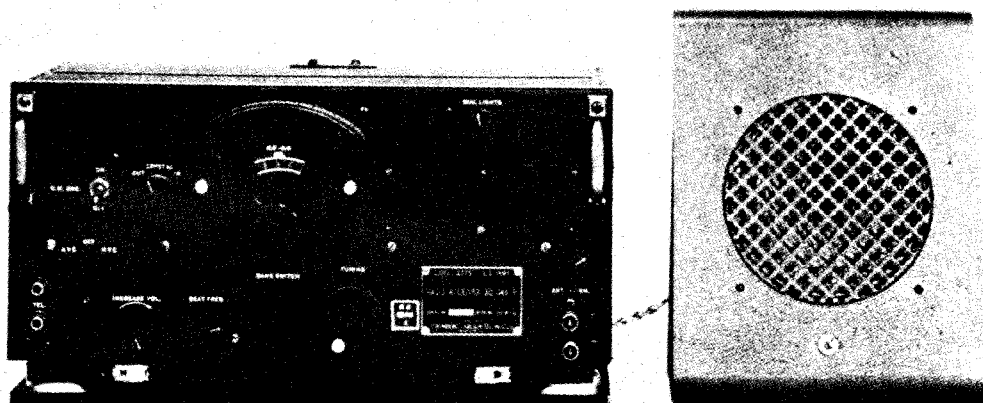
the old position) now serves as the crystal-out position, and the reduction in gain when the crystal filter is switched into the circuit will be very small.

A further change in the i.f. amplifier was made in the receiver shown in Figure 77 to bring out i.f. energy for the operation of external devices such as a panoramic adapter, a narrow-band F.M. adapter, or another external unit such as a single-sideband channel. The change consisted in merely wrapping 7 turns of hook-up wire around the form between the two i.f. coils inside the last transformer, connecting one side of this coil to ground and the other side to the center conductor of a piece of RG-58/U cable. The cable is brought into the transformer by first removing the capacitor to a soldering lug under the screw adjacent to the terminal from which the black wire was removed. It may be necessary to ream the hole from which the black wire was removed slightly in order to be able to insert the insulation and the inner conductor of the coaxial cable. The outer conductor of the coaxial cable is grounded outside the transformer. The coupling connector for the coaxial cable was mounted on the front panel of the receiver in the position formerly occupied by the power-cable connector, which had previously been removed.

With the i.f. energy obtained from the panel coaxial connector coupled to an external coil resonated to the intermediate frequency by means of a small 7-turn coupling coil, approximately 10 volts peak was measured with a normal signal input and the receiver operating on a.v.c. With the receiver on MVC, more than 50 volts peak could be obtained. This voltage is of course quite adequate to operate any of the accessories mentioned in the previous paragraph.

Figure 81.
BC-348P RECEIVER, SPEAKER
AND POWER SUPPLY

The power supply is mounted in the speaker housing.



Noise Silencer The noise silencer shown in Figure 80 has been found to be very effective on the 14-Mc. band, and on the 28-Mc. and 50-Mc. bands when a converter is used ahead of the receiver. One half of a 7A6 tube has been used, and since this tube draws only 150 ma. of heater current the heater may be fed with a balance to ground by means of two 22-ohm 2-watt carbon resistors from the 12.6-volt heater line. Or, if desired, the heater may be placed in parallel with the 6V6-GT heater as discussed in the previous paragraph. One half of a 6H6 or 6AL5 tube could also be used for the noise limiter, but these latter tubes require 300 ma. of heater current. It is possible that a 12H6 could also have been used, but one has not been tried. Make sure that the return for the noise limiter (the bottom end of C_1 , R_5 and R_4) is made to the *cathode* of the 6B8 and not to ground—if the return is made to ground proper noise-limiting action will not be obtained. A switch S_1 has been provided to take the noise silencer out of the circuit, since the circuit does introduce a detectable amount of distortion on a short-wave broadcast program.

Gain Control Changes It is a convenience in a communications receiver to have a separate control for audio and r.f. gain. To accomplish this in the series of receivers under discussion it is suggested that the dual control at the top of the panel be replaced by a single $\frac{1}{2}$ -megohm audio-taper potentiometer. C_{s1} and R_{s2} are removed, and the low-potential end of the audio gain control is returned to ground. The r.f. gain control leads can be pulled down to the underside of the chassis and connected to a separate 15,000-ohm r.f. gain taper rheostat which can be placed either in the position formerly occupied by the MIKE jack or just to the right of the

SEND-RECEIVE switch. The a.v.c. position of the switch will still short out the r.f. gain control in the conventional manner.

Control Circuits In the case of the BC-312 receiver as shown the 9-terminal power-connection strip was removed and the somewhat unsightly multi-connection receptacle on the front panel was removed and replaced by the "i.f. output" coaxial receptacle. Power and control connections were brought out to a 12-contact Jones P-312-RP connector which was mounted by means of a bracket to the rear of the chassis. The receptacle was aligned with the hole which already exists on the rear of the cabinet housing. The connector on the end of the power cable is a Jones S-312-FHT. The key, shorting relay, and switch inside the receiver were then rewired to connections on the connector on the rear of the cabinet as shown on Figure 80. The switch is connected so that it is in series with the center tap of the power transformer. Since a 12-volt keying relay is used on the transmitter, the antenna-shorting relay inside the receiver was wired so that it closed every time the transmitter keying relay closed.

In modifying the BC-342 series of receivers the external control circuit connections for the transmitter can be brought out of the front panel by replacing the connector which is installed on the front panel by an Amphenol MIP-8 octal socket, which fits the same mounting holes.

Hints on the BC-348 Series Receivers

The BC-348 series of receivers are quite satisfactory for communications use in the amateur station, but as in the case of the BC-312/BC-342 series, there

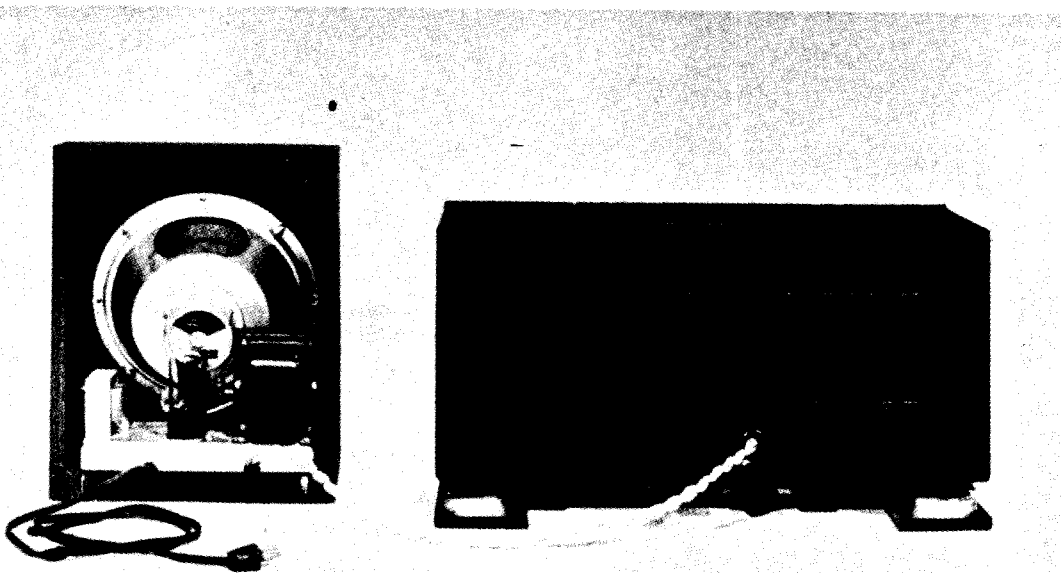


Figure 82.
REAR VIEW OF THE BC-348P
ASSEMBLY.

Showing the power supply mounted in the speaker housing and the octal power plug on the receiver.

are several minor modifications which may be made to improve the performance and flexibility of the equipments.

BC-348Q General Information

The BC-348 series of receivers may be operated with the heater circuits unchanged from a 26-volt a.c. supply. But a power transformer with such a filament winding is not readily available (although the C-228 transformer mentioned in connection with the BC-312 may be used with the filament windings in series) so it is in most cases best to rewire the heaters for operation from 6.3 volts. This means that one side of the heater of each tube should be grounded and the other side should be brought out as a common for feeding from the 6.3-volt line. In many cases the original "seriesing" wires between tube sockets may be used either for the grounded side or the hot side of the heater circuit, requiring addition of fewer wires and a solution to the problem of working in cramped spaces.

The a.c. power supply for the receiver may be mounted in the space formerly occupied by the dynamotor if space considerations and portability are very important. However, this procedure is not desirable from the standpoint of ventilation since an a.c. power supply dissipates a great deal more heat than the dynamotor originally installed. The space is more useful for additions to the receiver such as a noise limiter, an extra audio stage, or a broad-band converter.

The external a.c. operated power supply may be made somewhat oversize for operation of a frequency meter or a converter or an additional station accessory. In this event it is desirable to be able to ground the negative lead of the plate supply, which is not done on the BC-348Q. It is necessary to change the bias

circuits of the 6K6-GT audio stage and the 6SA7 converter to accomplish this. The first step is to ground the B minus and remove connections to choke 155-B and resistor 108-2. This leaves both the above stages unbiased. A 470-ohm 2-watt resistor should be placed in series with the cathode terminal of the 6K6-GT audio stage. A 25-volt 25- μ fd. electrolytic capacitor should be placed across this cathode resistor.

About 1.8 volts of bias is used on the grid of the 6SA7 converter stage. To obtain this, resistor 108-1 in the oscillator can be clipped out of the receiver. The contact at the junction of this resistor and resistor 87-2 is available as a projecting lug. Upon this lug may be mounted a standard miniature bias cell with the positive side grounded and the negative side to the lug.

Audio Considerations in the BC-348Q

Addition of a noise-limiter (see *Radio Handbook*) will improve operation in the presence of ignition interference on the 14-Mc. band and is almost a necessity for use of the receiver with a converter on the 28-Mc. or 50-Mc. bands. The addition of an extra stage of audio is also desirable, especially for use with the crystal filter on 14-Mc. c.w. The added tube may be a 6SF5 triode with conventional circuit values (see any standard reference), or a 6SJ7 stage with feedback may be added.

Difficulty may be encountered with the audio system of the receiver after the addition of the audio stage and the noise limiter due to the common cathode resistor on the second detector and the third i.f. stage. This trouble may be avoided by isolating these two cathode circuits. The lead between the two cathodes is removed and resistor 105 is either removed or short-

ed. This leaves the third i.f. stage with resistor 102 and capacitor 61-4 in its cathode circuit to ground. The cathode of the second-detector tube is now grounded to the chassis. The large capacitor can 70-A and 70-B may now be removed to make additional room inside the equipment. The 6- μ fd. section is ideal as a portion of the filter capacitance in the external power supply. The lead at the low-potential side of the third i.f. transformer should be opened and the noise limiter inserted at this point. Capacitor 27-3 should be left to by-pass the secondary of the transformer. The on-off switch for the noise silencer may be placed in a panel position in place of one of the head-phone jacks.

Mechanical Considerations If a plug to fit the rear connector block cannot be secured, an octal socket may be fitted into the set by liberal use of a round file and then by drilling and tapping mounting holes for the socket. If the cast aluminum guide box is removed from the case it will not be necessary to enlarge the rectangular hole in the case to pass an octal power plug.

A socket punch may be used to make two holes in the back of the case. One hole is used to pass the plug for the speaker connection, and the other hole to reach a two-post terminal strip which is wired to the receiver silencing circuit (terminals 2 and 6 in the circuit diagram). These two terminals may then be shorted or wired into the transmitter control circuit in such a manner that the receiver is disabled whenever the transmitter is on the air.

The seriesed dial lamps should be parallel and connected to the 6.3-volt heater circuit with the dial light control resistors 111 and 81 out of the circuit.

BC-348E, M, and P Receivers Changes in this series of receivers are generally the same as in the (J), (N), and (Q) series of 348's, except that only the power audio stage must be modified when grounding the negative lead of the power supply. Also, the second detector and third i.f. stage cannot be isolated since they are in the same tube envelope.

Figures 81 and 82 show a convenient method whereby the power supply for a BC-348 series receiver may be mounted in the housing for the loud-speaker.

A 120 to 140 Watt Modulator from the BC-375 or BC-191

One way in which to solve the problem of making good use of the BC-375E or the BC-191 is to disassemble the tuning drawers for components, use the housings for the tuning drawers as cabinets for accessory pieces of test equipment, and use the main housing of the transmitter along with the audio transformers and miscellaneous other components to assemble a modulator. Figures 83 and 84 show one such assembly which operates quite satisfactorily.

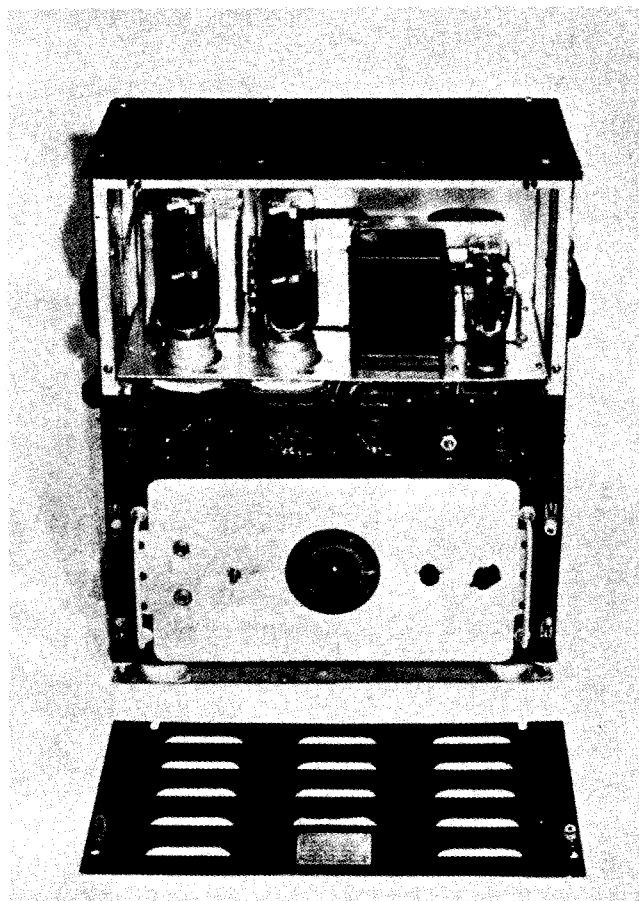


Figure 83.

MODULATOR AS MADE FROM A BC-375E.

The front cover has been removed to show the placement of components on the new chassis.

All components on the upper deck were removed, including the chassis, and a new chassis was bent from sheet aluminum to hold the components shown in Figure 85. The end of the main housing which held the antenna tuner was sawed off as unnecessary, but it might be retained to house the power supply for the modulator if components of the proper dimensions should be obtainable. The components mounted on the upper deck of the chassis include the power supply for the speech amplifier, a simple regulated bias circuit for the negative 100 volts on the 211 grids, and the audio transformers.

The clipper-filter audio amplifier and driver is mounted in the housing for one of the tuning drawers after all the r.f. components had been removed. The circuit for the speech amplifier is shown in Figure 86. An additional panel was placed in front of the original panel to cover the multitude of holes that had been left by removal of the r.f. components. The clipper-filter speech amplifier is quite conventional, ending in a single-ended 6B4-G which acts as driver for the 211's. Provision has been made in the input circuit of

AN/ART-13 Autotune Aircraft Radio Transmitter

The AN/ART-13 Autotune aircraft radio transmitter makes a very satisfactory amateur transmitter for phone and c.w. operation on the 80, 40, 20 and 10 meter bands. Under normal conditions the transmitter operates very stably and puts out a cleanly modulated or smoothly keyed signal when it is running about 200 watts input. The Autotune feature is a great operating convenience whether the transmitter is to be remotely controlled or controlled from the operating position. With the circuit modifications described herein the Autotune system allows operation on 10 preset frequencies throughout the 80, 40 and 20 meter bands and one additional frequency in the 10 or 11 meter band. Operation with phone or c.w. on any one of these frequencies is obtained simply by moving the panel selector switch to the desired position and waiting approximately 25 seconds for the Autotune system to operate. If desired, several frequencies separated by not more than about 50 kc. may be set up in the 28-Mc. band with an increasing reduction in the frequencies available for lower frequency operation.

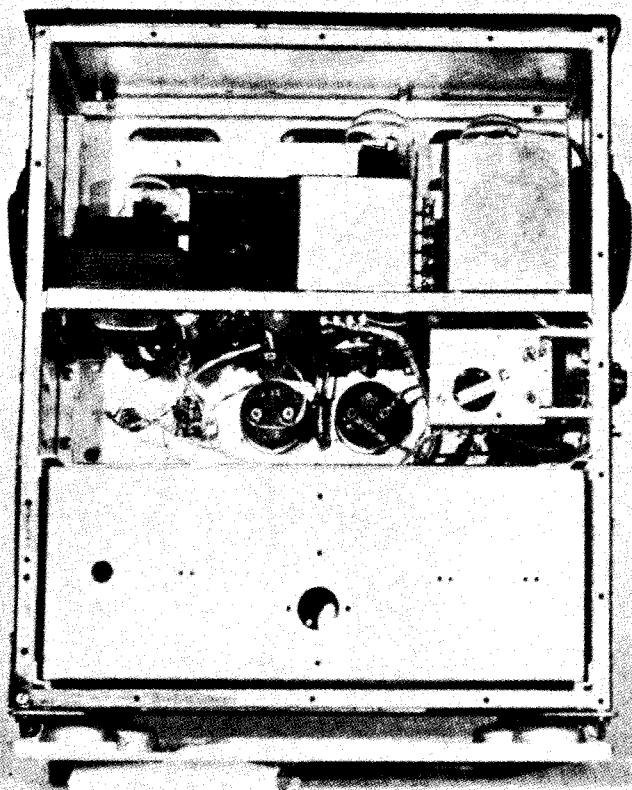


Figure 84.

REAR VIEW OF THE BC-375E MODULATOR.

the speech amplifier for both a single-button microphone and a crystal-microphone input, with a switch S to select either input circuit. The clipping level control R_{14} , must be substantially full open for maximum undistorted output from the 211 tubes in the output stage.

Measurements of the complete modulator, with a 1250-volt power supply feeding plate voltage to the 211 tubes, showed that it was possible to obtain 120 watts of audio output from the tubes with no distortion discernible to the ear or noticeable on the oscilloscope. An output of 145 watts was obtained with an amount of distortion which would be quite tolerable for amateur communications work. No heating of the output transformer was noticed with 120 watts output from the stage into a 7000-ohm load resistor over a test period of about one hour.

The 7000-ohm load impedance could be represented by a Class C modulated r.f. amplifier operating from the same plate supply as the 211's (1250 volts) at a plate current of 180 ma. This represents an input of 225 watts to the Class C stage, an amount which may be modulated without difficulty by the modulator unit.

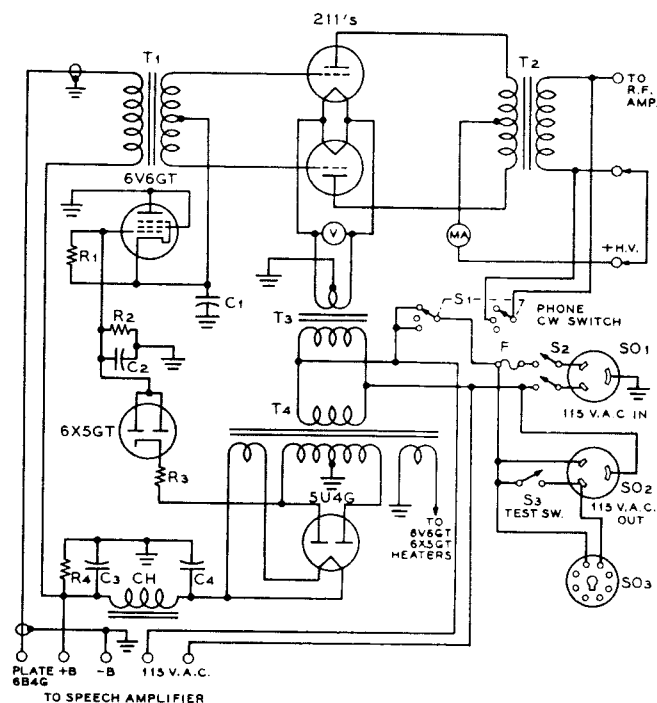


Figure 85.

MAIN ASSEMBLY SCHEMATIC OF THE BC-375E MODULATOR.

- | | |
|--|---|
| C_1 —8- μ fd. 450-volt elect. | T_1 —700 v. c.f. 90 ma., 5 v. 3 a., 6.3 volts 2 amperes |
| C_2 —40- μ fd. 350-volt elect. | CH—12-hy. 90-ma. choke |
| C_3, C_4 —8- μ fd. 450-volt elect. | MA—0-500 d.c. ma. from 375E |
| R_1 —100,000 ohms $\frac{1}{2}$ watt | V—Voltmeter from 375E |
| R_2 —7500 ohms 10 watts | S_1 —Phone c.w. switch from 375E |
| R_3 —5000 ohms 10 watts | S_2 —Main a.c. line switch |
| R_4 —50,000 ohms 20 watts | S_3 —S.p.s.t. test switch |
| T_1 —Driver trans. from 375E | SO_1, SO_2 —Twistlock receptacles |
| T_2 —Mod. trans. from 375E | |
| T_3 —10-volt 6.5-amp. fil. trans. | |

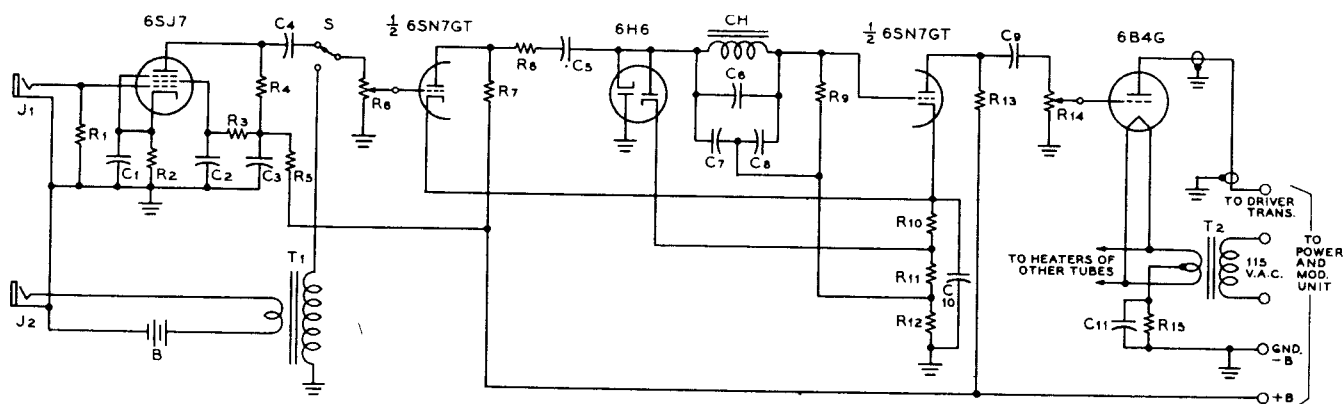


Figure 86.

SCHEMATIC OF CLIPPER-FILTER SPEECH AMPLIFIER FOR THE BC-375E MODULATOR

C₁—25- μ fd. 25-volt elect.
 C₂—0.1- μ fd. 400-volt tubular
 C₃—8- μ fd. 450-volt elect.
 C₄—0.01- μ fd. 400-volt tubular
 C₅—0.1- μ fd. 400-volt tubular
 C₆—175- μ fd. mica
 C₇, C₈—200- μ fd. mica
 C₉—0.01- μ fd. 400-volt tubular

C₁₀—25- μ fd. 25-volt elect.
 C₁₁—10- μ fd. 100-volt elect.
 R₁—1.0 megohm $\frac{1}{2}$ watt
 R₂—1300 ohms $\frac{1}{2}$ watt
 R₃—1.5 megohms $\frac{1}{2}$ watt
 R₄—220,000 ohm $\frac{1}{2}$ watt
 R₅—47,000 ohms $\frac{1}{2}$ watt

R₆—500,000-ohm potentiometer
 R₇—100,000 ohms 1 watt
 R₈—100,000 ohms $\frac{1}{2}$ watt
 R₉—100,000 ohms 1 watt
 R₁₀—330 ohms $\frac{1}{2}$ watt
 R₁₁, R₁₂—620 ohms $\frac{1}{2}$ watt
 R₁₃—47,000 ohms 1 watt

R₁₄—250,000-ohm potentiometer
 R₁₅—750 ohms 10 watts
 T₁—Mike-to-grid transformer
 T₂—6.3 volts at 3 amperes
 CH—3.5 to 3.75 henry choke
 J₁—Crystal-mike jack
 J₂—Carbon-mike jack

Power Supply The major change required to adapt the ART-13 for amateur use is that of providing for operation of the equipment from the 115 volt a.c. line. All other changes described are in the nature of operating conveniences or are for the purpose of obtaining operation in the 28 Mc. region.

The simplest way of converting the equipment is to provide a source of 26 volts d.c. at about 9 amperes for operation of the tube filaments and heaters and for the relays and Autotune motor. Conventional a.c. operated power supplies are then used for plate and grid bias voltages. However, due to the difficulty in obtaining components for a high current 26-volt d.c. supply, it was deemed desirable in the conversion portion to use a 4-ampere 26-volt d.c. supply for the heater tubes relays and Autotune motor, and to supply the filaments of the 813 and the 811 from filament transformers.

The power supply unit shown in Figure 88 has been designed and constructed especially for operation with the AN/ART-13 transmitter. In addition to a complete set of control circuits the unit supplies the following potentials to the ART-13 through the power cable: 1250 volts at a maximum of 300 ma., 400 volts at 225 ma., 26 volts at 4 amperes, 350 volts of negative bias for keying the 813, and 115 volts a.c. for the blower and for the filament transformers for the 811's and the 813. The power supply is housed in a standard cabinet which takes a 12 $\frac{1}{4}$ by 19 inch front panel. Careful component placement is necessary to house the power supply unit in a cabinet of this size.

Several of the components used in the 26-volt d.c. supply are surplus items since standard manufactured items are not available. In certain cases it will be necessary to have either the transformer or the filter choke for the 26-volt d.c. supply made up especially

for the job. If a 10-ampere 26-volt output selenium rectifier is obtainable it will probably be best to have a 10-ampere power transformer and choke wound also so that no changes will be required in the filament circuits of the transmitter. The high voltage power supply and control circuits can be the same whether the filaments are all lighted from d.c. or some of them are lighted from d.c. and some from a.c.

Initial operation of the equipment at full input for a period of time showed that considerable heating takes place in the region behind the plate tank circuit for the 813. It was therefore deemed desirable to install a cooling exhaust blower on the back of the equipment. The particular blower used is a surplus item but similar a.c. operated blowers running at approximately 1500 r.p.m. are available from the larger hardware stores. With this blower in operation the unit runs quite cool and overheating of components is completely eliminated even with long periods of operation. In the particular unit shown in Figure 87 the blower has been mounted in a box on the rear of the housing for the transmitter with the filament transformers for the 811's and the 813 also included within this box.

Control Circuit A time-delay relay which operates from the 26-volt d.c. supply has been included in the equipment to insure that all tubes have reached normal operating temperature before plate voltage is applied. If a 26-volt time delay is not available, a 115-volt a.c. relay of the same type may be used. Protective interlocks have been provided in the power supply unit and in the actual cabinet for the ART-13 transmitter. These two interlocks are connected in series and in turn the two of them are connected in series with the lead to the plate power relay

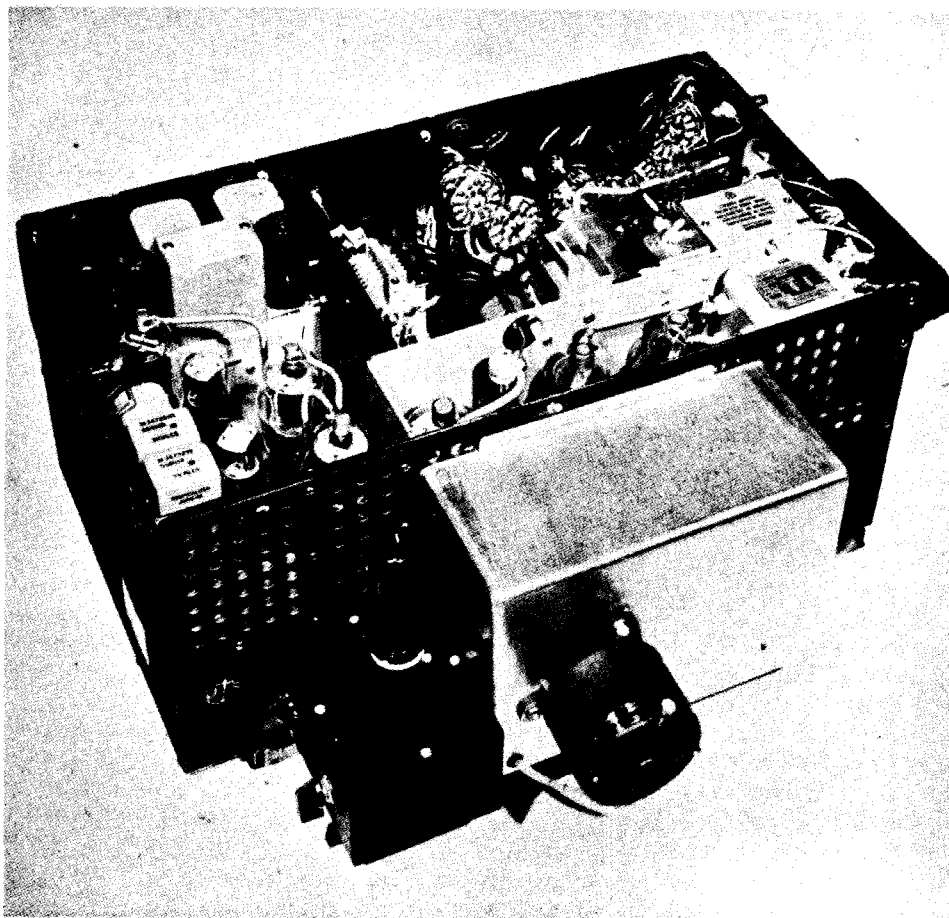


Figure 87.
TOP OF THE CONVERTED
AN/ART-13.

The box containing the blower and the filament transformers for the 813 and the 811's can be seen on the rear alongside the small box which holds the 6L6 multiplier for the 28-Mc. band. The 28-Mc. tank for the 813 can be seen inside the Cabinet.

RY_1 so that plate voltage cannot be applied to the transmitter if the cover has been removed from the ART-13 or if the top door to the power supply box has been opened.

Provision has been made in the control circuit for the transmitter so that when S_{110} on the front of the ART-13 or its counterpart at the remote control position is moved from the off to either the voice or the c.w. position, the transmitter will be turned on. Since this switch closes a circuit to ground, it was necessary to find an isolated source of potential to operate the main control relay. This source of potential was obtained by leaving the small transformer T_4 connected across the line at all times that the unit is plugged into the socket. However, when the transmitter is switched off there is no power drain from any of the secondaries of this transformer.

The push-to-transmit circuit which has been included in the power supply unit is very pleasing to operate and relatively simple in design. It consists of a single 6C5 tube operating from the bias supply along with its associated components. The complete circuit is shown in Figure 88. When the key is up relay RY_5 is open and the voltage drop across R_5 to the slider is impressed on the grid of the 6C5 tube, cutting off its plate current. When the key is pressed RY_5 closes

and the right-hand side removes the blocking grid bias from the 813 by shorting the grid return to ground through R_9 and CH_6 . These latter two components in conjunction with C_8 make up a very effective key-click filter. The effectiveness of the circuit is illustrated by the fact that clicks cannot be heard from the transmitter on a communication receiver tuned to the same band for break-in c.w. operation.

At the same time that RY_5 is closing, the other set of contacts on this relay shorts the grid of the 6C5 to its cathode, causing full plate current to flow through RY_6 and R_7 , thus closing RY_6 . When RY_6 closes the antenna changeover relay in the ART-13 operates and plate voltage is applied to the transmitter by RY_1 . Then when the key is lifted RY_5 opens so that plate current to the 813 is stopped, but due to the time constant of the R_6 - C_6 combination, plate current still flows through RY_6 . Hence the plate voltage remains on the transmitter and the antenna relay is still in the transmit position. The transmitter remains in this condition until the voltage across C_6 has built up to such a value that RY_6 drops out, changing everything back to the receive condition. The amount of this delay is variable, by adjustment of potentiometer R_5 from a fraction of a second up to about 15 seconds. The normal setting is for about 3 seconds so

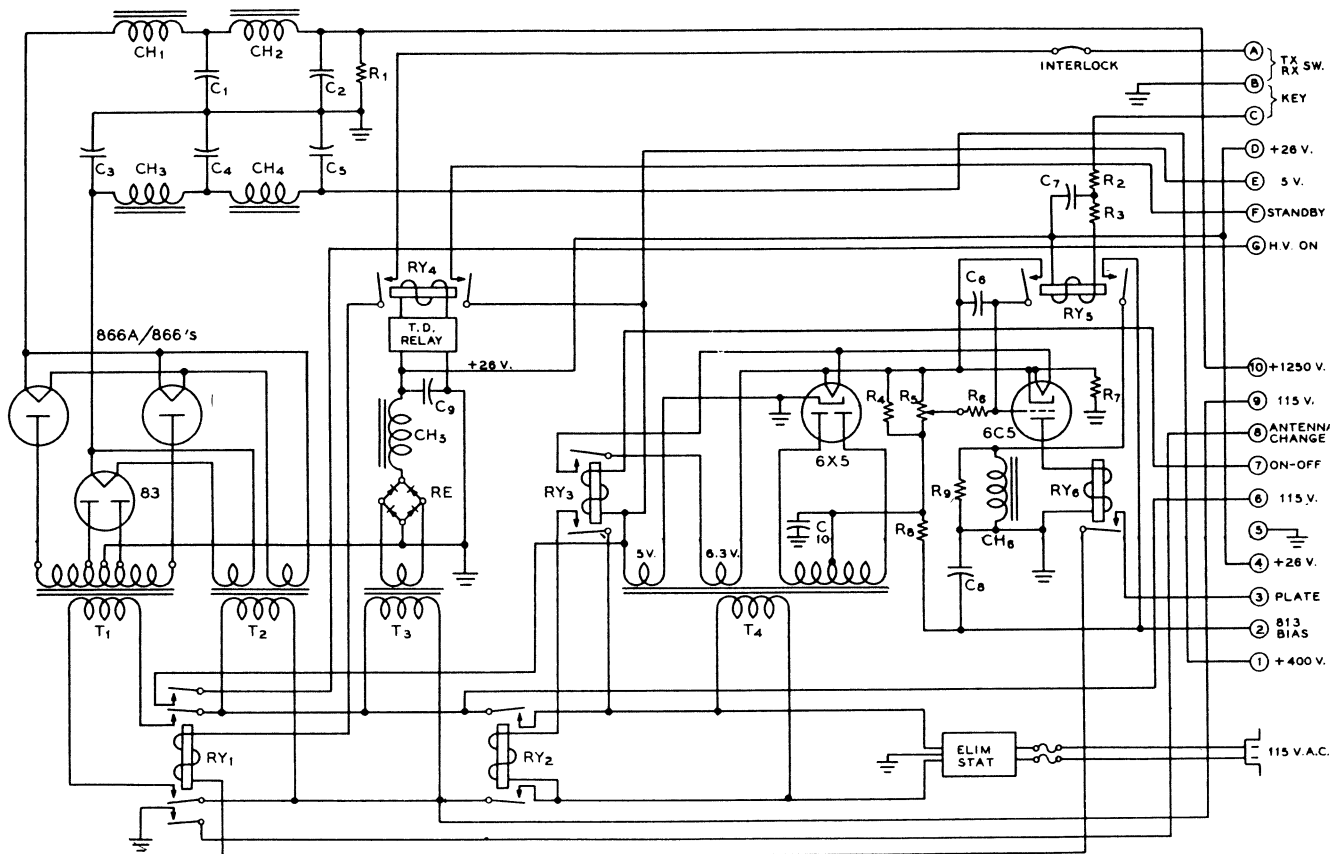


Figure 88.

SCHEMATIC DIAGRAM OF THE POWER SUPPLY FOR THE AN/ART-13.

C₁, C₂—4- μ fd. 1500-volt capacitors
 C₃, C₄—4- μ fd. 600-volt capacitors
 C₅—10- μ fd. 600-volt capacitor
 C₆—0.5- μ fd. 600-volt tubular
 C₇—0.1- μ fd. 400-volt tubular
 C₈—0.05- μ fd. 400-volt tubular
 C₉—4000- μ fd. 50-volt elect.
 C₁₀—8- μ fd. 450-volt elect.
 R₁—50,000-ohm 100-watt bleeder
 R₂, R₃—22 ohms 2 watts

R₄—10,000 ohms 10 watts
 R₅—100,000-ohm potentiometer
 R₆—2.7 megohms 1/2 watt
 R₇—15,000 ohms 10 watts
 R₈—50,000 ohms 20 watts
 R₉—15,000 ohms 2 watts
 T₁—1500 v. each side at 300 ma., 400 v. each side at 175 ma., common c.t. (UTC PA-303)
 T₂—5 v. 3 a., 2.5 volts 10 a.
 T₃—700 v. c.t. 70 ma., 5 v. 2 a., 6.3 v. 2 a. (UTC R-2)
 T₄—35 volts at 5 a. (special)

CH₁—250-ma. swinging choke
 CH₂—250-ma. filter choke
 CH₃, CH₄—200-ma. filter chokes
 CH₅—0.05 henrys at 4 amp. (special)
 CH₆—13-henry 65-ma. filter choke
 RY₁—28-volt d.c. 4-pole d.t. relay
 RY₂—115-volt a.c. 2-pole relay
 RY₃—6.3-volt or 5 volt 2-pole relay (RY₂ and RY₃ may be combined if contacts of

RY₃ can carry about 8 amperes and if 3 contacts are available.)

RY₄—28-volt d.c. time-delay relay (115-volt a.c. time-delay relay may be used across primary of T₃ if 28-volt relay not avail.)
 RY₅—28-volt d.p.d.t. keying relay
 RY₆—2500-ohm sensitive relay
 Elimstat—A.c. line filter

that the plate voltage will remain on for the normal short pauses in a c.w. transmission but will drop back to the receive condition 3 seconds after a transmission has been completed.

Changes in ART-13 Control Circuits

It is necessary to make a certain number of modifications in the various circuits of the ART-13 in order to allow the equipment to operate from the power supply unit described before and illustrated in Figure 88. It is necessary first that the meter switch circuit be changed in the following manner: Remove ground from bottom end of R₁₁₁ (235-ohm resistor) and connect this end of the resistor to terminal A₂ of S₁₀₅. Remove the wire that now goes to terminal B₃ of S₁₀₅ and connect this wire to terminal A₂ of S₁₀₅ along with the bottom end of

R₁₁₁ above. This series of changes brings the grid return of the 813 tube out to terminal 2 on the main power connector J₁₀₈.

The following changes are required in the power control circuits: Ground the lead inside the cabinet which now goes to terminal 8 on J₁₀₈. Remove the lead now going to terminal 14 of J₁₁₆ which is mounted on the side of the antenna changeover relay K₁₀₂. Insulate this lead. Now run a lead from terminal 8 of J₁₀₈ to terminal 14 of J₁₁₆. A lead is now run from terminal 2 on the loading coil relay connector J₁₀₇ to terminal C in the power supply unit. This is the only lead brought out of the transmitter which does not go through the main power connector J₁₀₈.

The filaments of the 813 and of the 811's should be re-wired to operate from separate transformers mounted on the rear of the equipment. One side of

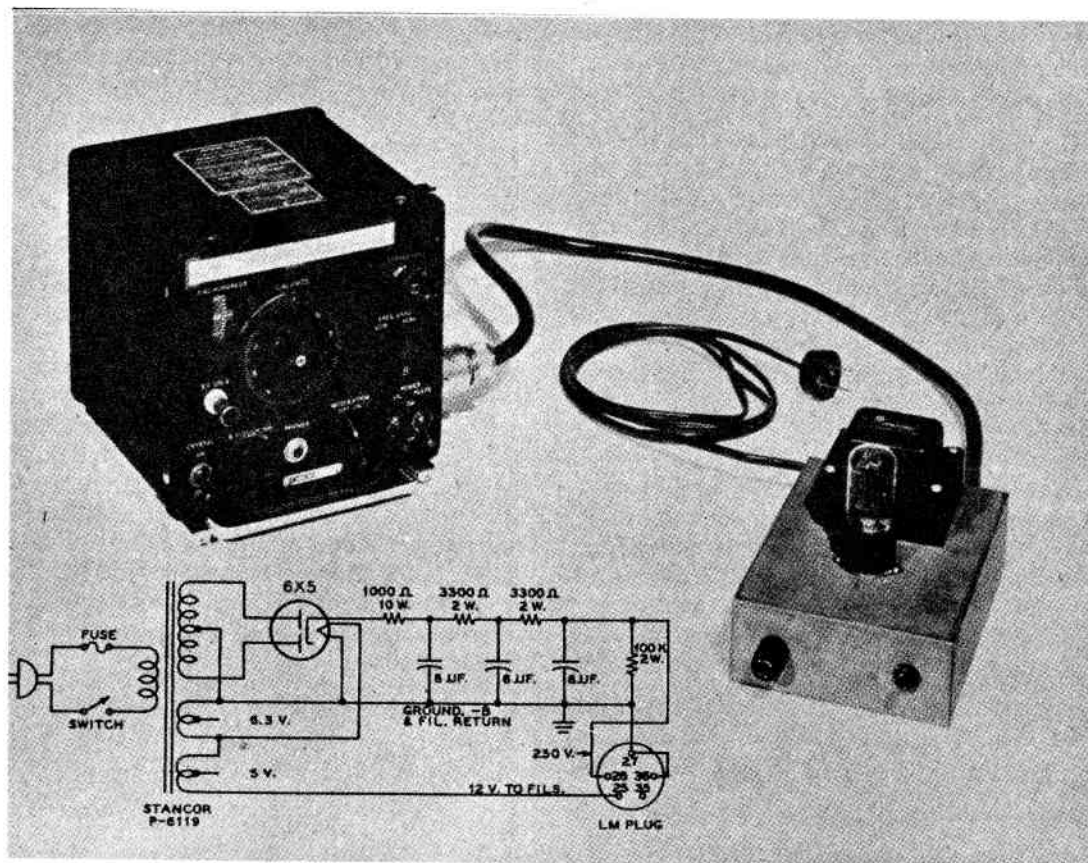


Figure 90.
SCHEMATIC OF THE SIMPLE
LM POWER SUPPLY.

The 5-volt and 6.3-volt windings on the transformer are connected in series to obtain filament voltage for the LM. Due to the light load on the filament windings the fila-

ment voltage measures about 11.9 volts on the filament lead. This value of voltage is well within the filament voltage tolerance of the heater tubes used in the frequency Meter.



Figure 91
PHOTOGRAPH OF
THE SIMPLE LM
POWER SUPPLY.

An LM frequency meter is shown alongside the power supply for comparison.

which has been placed in the position inside the cabinet of the ART-13 which was designed to hold the low-frequency oscillator unit. In the particular transmitter shown the 28-Mc. tank for the 813 consisted of a 6-turn coil of number 10 enamelled wire $1\frac{1}{4}$ inches in diameter and $1\frac{1}{2}$ inches long. A two-turn link feeding a piece of 300-ohm line is then run over to the left wall of the transmitter where it terminates in a pair of terminals. With this tank the 813 dips to about 30 ma. on 28 Mc.

The two terminals which close K_{105} may be picked up as terminals 7 and 4 on the connector J_{115} which feeds plate and filament supply to the multiplier unit of the ART-13. Two leads from these two terminals are run to the 6L6 multiplier unit so that they are closed whenever the 6L6 is in operation. With the 6L6 frequency tripler as shown it is possible to obtain half scale on the grid current meter throughout the 28-Mc. band; this represents about 8 to 9 ma. of grid current on the 813.

Note in Regard to the Output Network of the ART-13

The output network of the AN/ART-13 is designed to operate as an "L" network on frequencies up through about 5 Mc. This is required since the transmitter was designed to feed an antenna installed on an aircraft which would have a very low radiation resistance at these low frequencies but would have a relatively large value of capacitance to ground. This network will *not* feed satisfactorily the type of antennas commonly used by amateurs for fixed-station use in the 3.5 to 4 Mc. band. Hence it is desirable to convert the L network into a pi network when operating on the 80-meter band. The simplest way to do this is merely to place a capacitor of 100 to 400 μfd . from the "COND" terminal on the left end of the transmitter to the ground terminal on the case. A variable capacitor may be used to determine the best value for this capacitor, and then a fixed air capacitor or a ceramic transmitting capacitor of the type used in the transmitter may be hooked in place. Experiment

showed that a value of about 200 $\mu\text{fd.}$ was best for feeding a folded dipole with 300-ohm twin line on the 3.5-Mc. band.

Tests of the completed transmitter have shown that there is no appreciable increase in output after the plate current on the 813 is increased above 160 ma. This represents a power input of 200 watts at 1250 volts and the plate circuit efficiency runs from 70 to 75 per cent on all bands. The out-of-resonance plate current will be from 180 to 200 ma. with normal excitation, and antenna coupling should be adjusted until 160 ma. of plate current is drawn by the 813 tube.

Simple A.C. Power Supply for the LM Frequency Meter

Figures 90 and 91 illustrate a very simple power supply for operation of one of the LM series frequency meters from the 115-volt a.c. line. Plate voltage for the frequency meter is obtained from a small power transformer with a 6X5-GT rectifier. Due to the very low plate current requirements of the frequency meter a resistance-capacitance filter has been used on the

plate voltage supply. With the transformer shown and the values of resistance and capacitance listed the plate voltage supplied to the frequency meter is 255 volts. This voltage is sufficient to cause the neon regulator tubes to strike with certainty when the voltage-change strap in the LM is adjusted to the 200-260-volt position.

By connecting the two filament windings on the power transformer in series it is possible to obtain adequate heater voltage for the frequency meter. Due to the light load on these two filament windings the voltage applied to the LM under normal operating conditions is 11.9 volts; this value of voltage is well within the plus or minus 10 per cent heater voltage limit on the tubes used in the equipment. Through the use of a 6X5-GT rectifier, which has the heater well insulated from the cathode, the rectifier may be lighted from the same filament windings, which light the tubes in the frequency meter. No changes whatever are required inside the LM frequency meter when it is used with the power supply shown in these illustrations.

LIST OF EQUIPMENT

on which data is given in Volume I of the
"Surplus Radio Conversion Manual"

BC-221 Frequency Meter
BC-342 Receiver
BC-312 Receiver
BC-348 Receiver
BC-412 Radar Oscilloscope (Conversions for
TV Receiver and Test Oscilloscope)
BC-645 Transmitter-Receiver (420 Mc.)
BC-946B Receiver (Conversion to Auto Receiver)
SCR-274N (BC-453A Series) Receivers
(Conversion to 10-meters)
SCR-274N (BC-457A Series) Transmitters
(Conversion to V.F.O.)
SCR-522 (BC-625) Transmitter (Conversion to
2 meters)
SCR-522 (BC-624) Receiver (Conversion to
2 meters)
TBY Transceiver (Conversion to 10 and 6 meters)
BE-103A Dynamotor
BC-1068A/1161A Receiver (2 meters)

LIST OF EQUIPMENT

on which data is given in Volume II of the
"Surplus Radio Conversion Manual"

ARC-5 (B-454) Receivers (Conversion to 28 Mc.)
AN/APS-13 Transmitter-Receiver
(Conversion to 420 Mc.)
ARC-5 (BC-457) Transmitters (Conversions to
28 Mc.)
Selenium-Rectifier Power Units
ARC-5 V.H.F. Transmitter-Receiver Operation
GO-9/TBW Transmitter (Conversion to 28 Mc.)
BC-357 Marker Receiver (Conversion to
Capacity Relay)
BC-946B Receiver (Conversion to
High-Fidelity Tuner)
BC-375 Transmitter (use with external V.F.O.)
TA-12B/C Transmitter Conversion
AN/ART-13 Transmitter (Conversion to A.C.
and 28 Mc.)
Coil-Winding Charts
AVT-112A Transmitter for Light Aircraft
AM-26/AIC Interphone Amplifier (Conversion
to 9-watt Amplifier)
LM Frequency Meter
Beam Rotating Mechanisms
ARB Receiver (Schematic only)

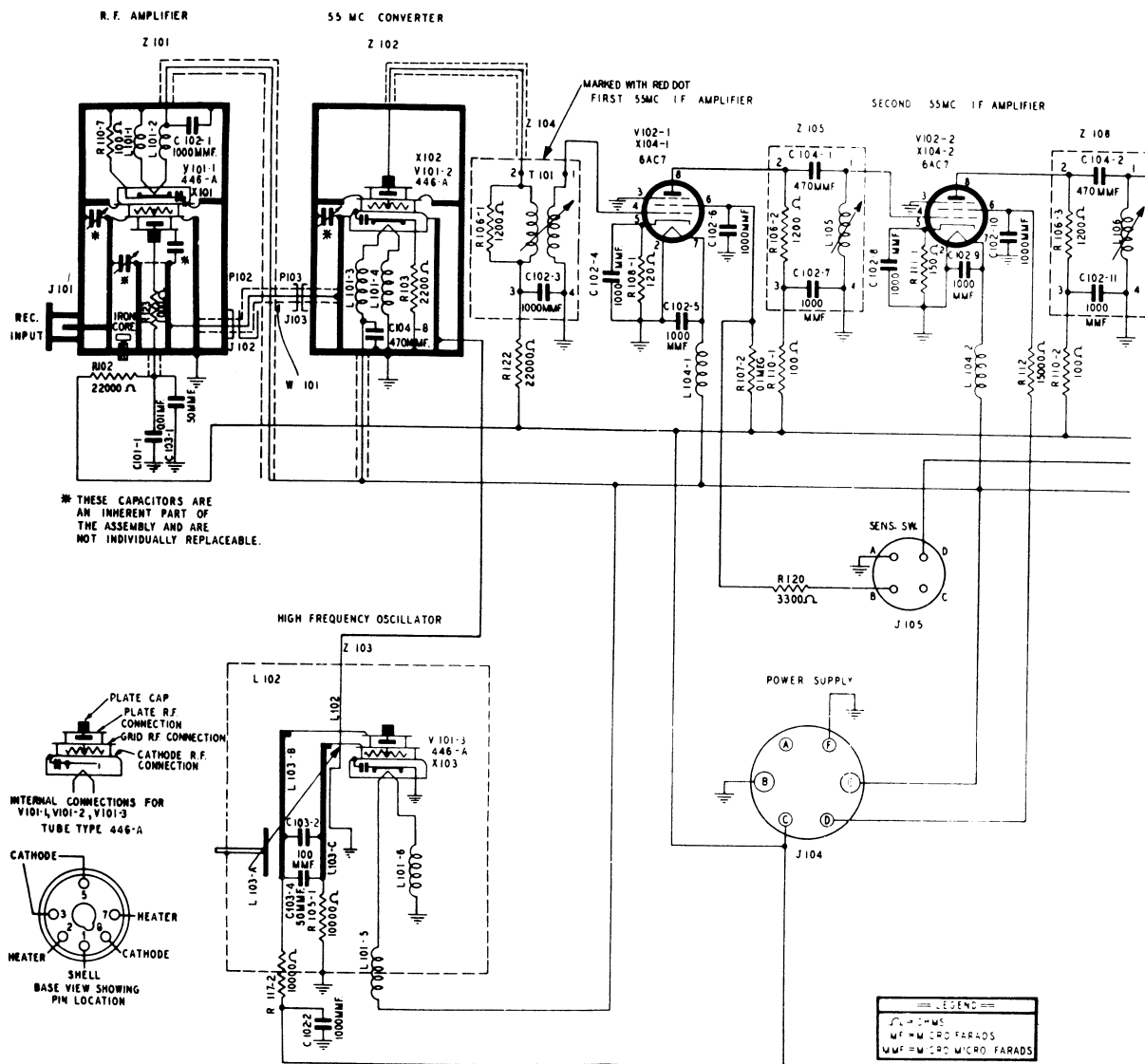


Diagram continued on page 79

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Figure 93

RECEIVER UNIT, CPR-46ACJ, SCHEMATIC DIAGRAM

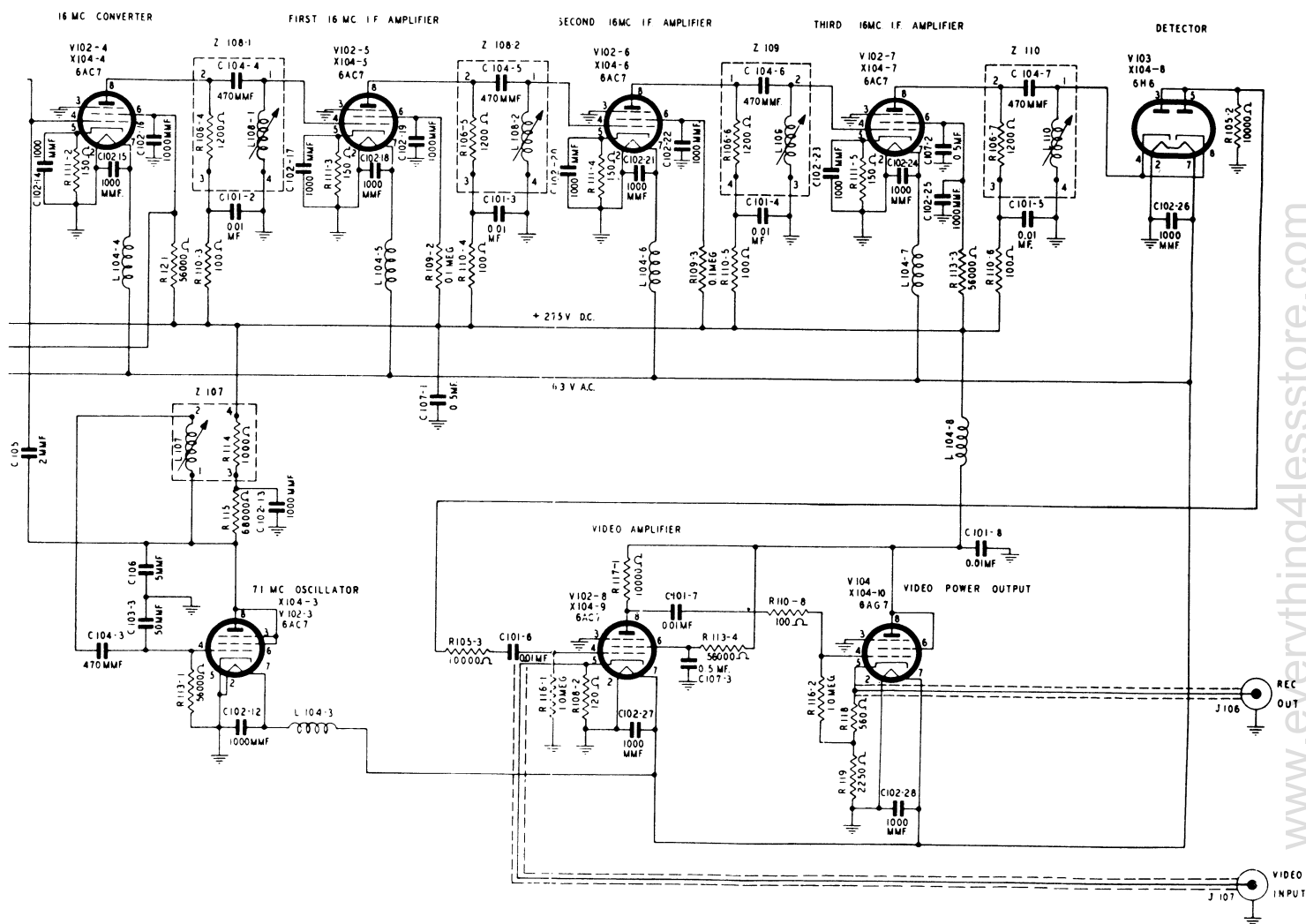


Figure 93
RECEIVER UNIT, CPR-46ACJ, SCHEMATIC DIAGRAM

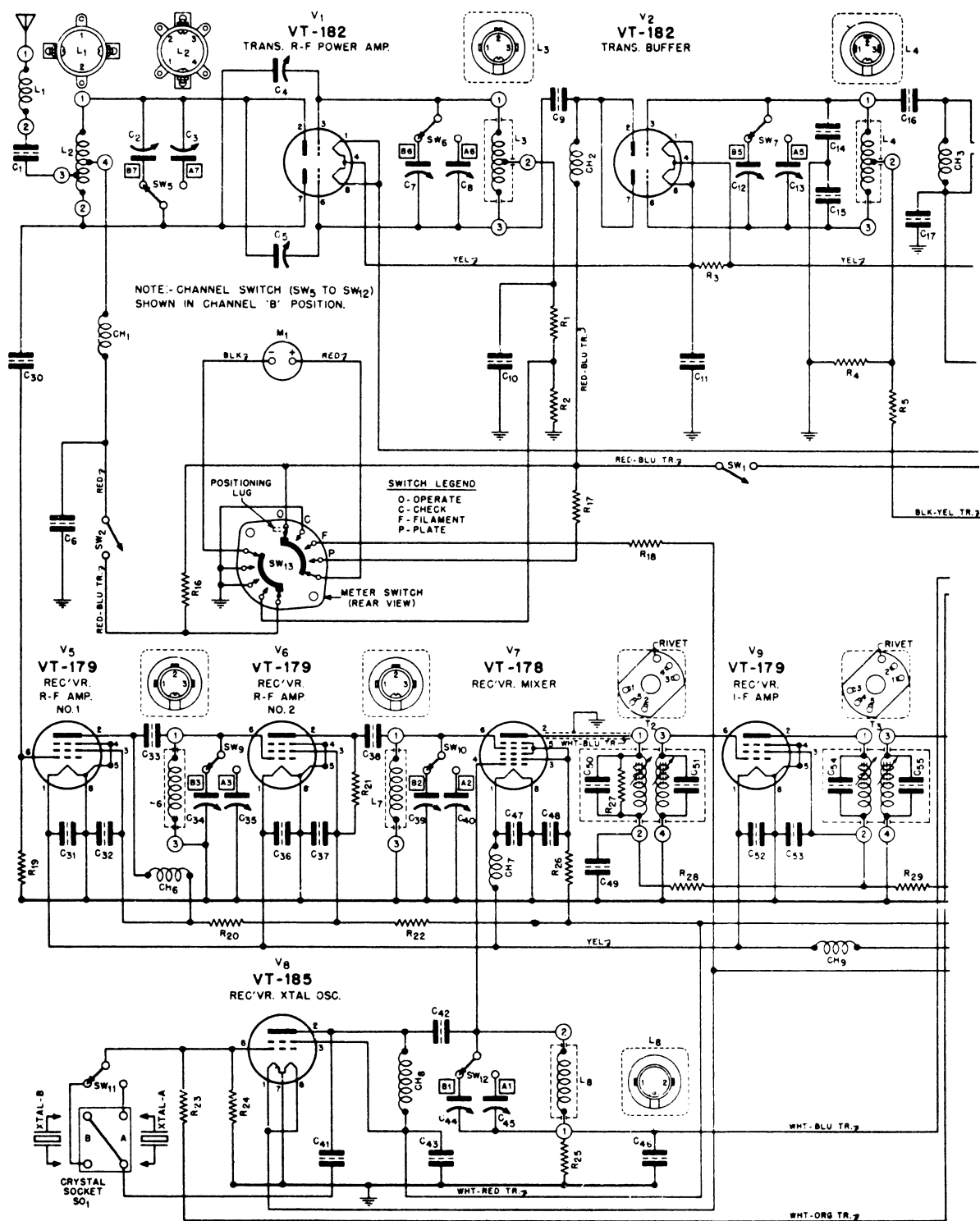


Figure 94
SCHEMATIC, BC-659 RECEIVER AND TRANSMITTER

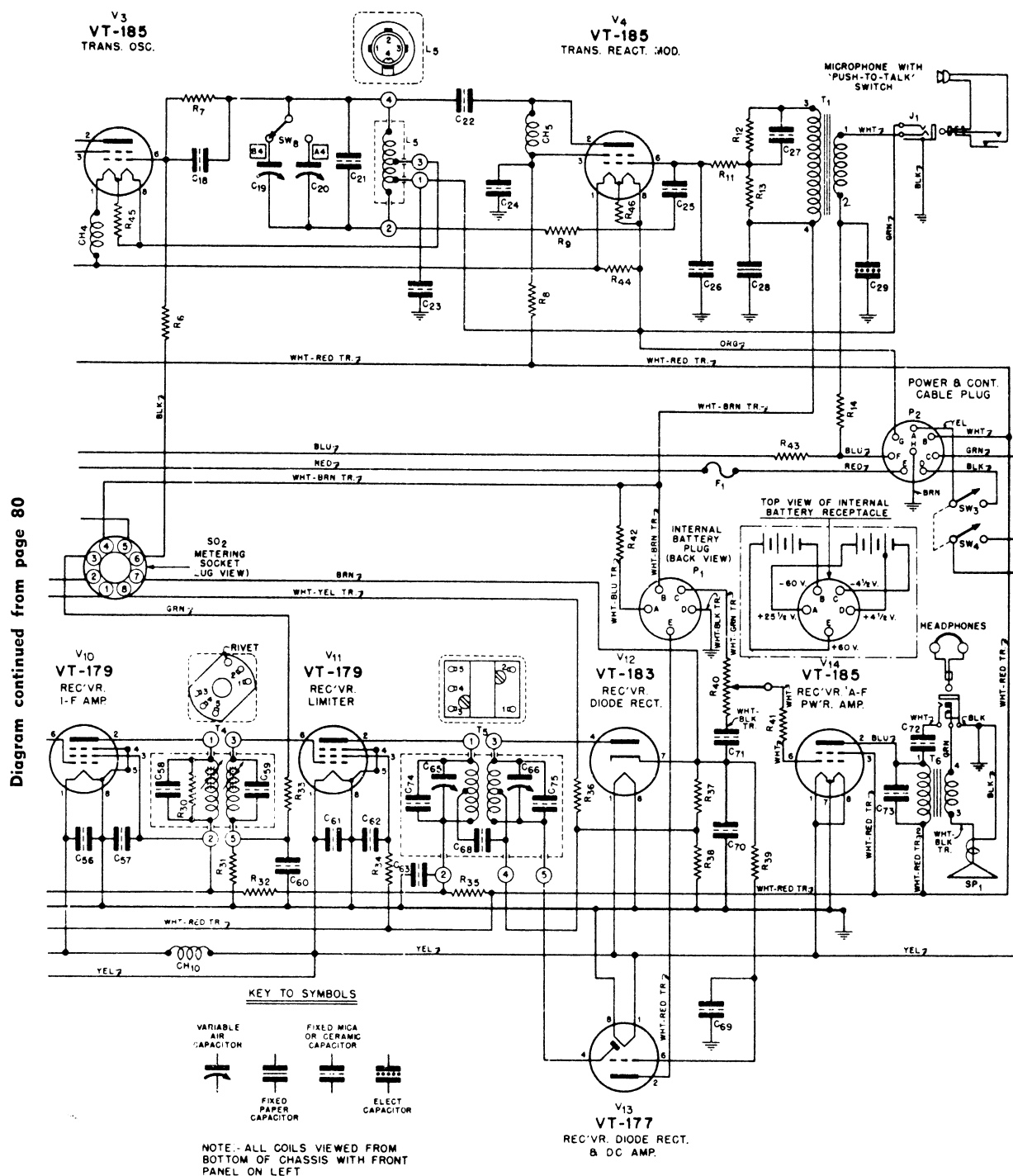
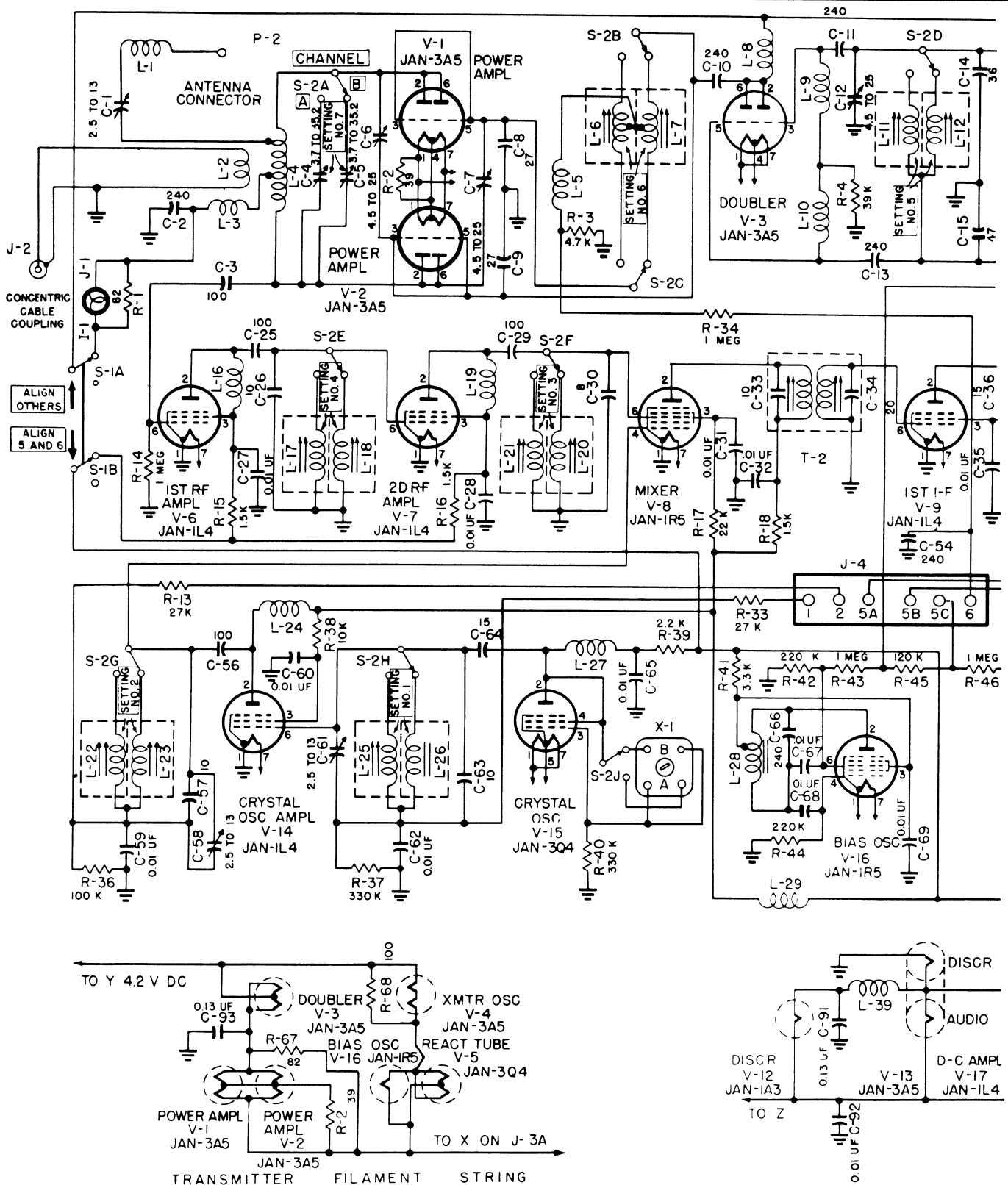


Figure 94
SCHEMATIC, BC-659 RECEIVER AND TRANSMITTER

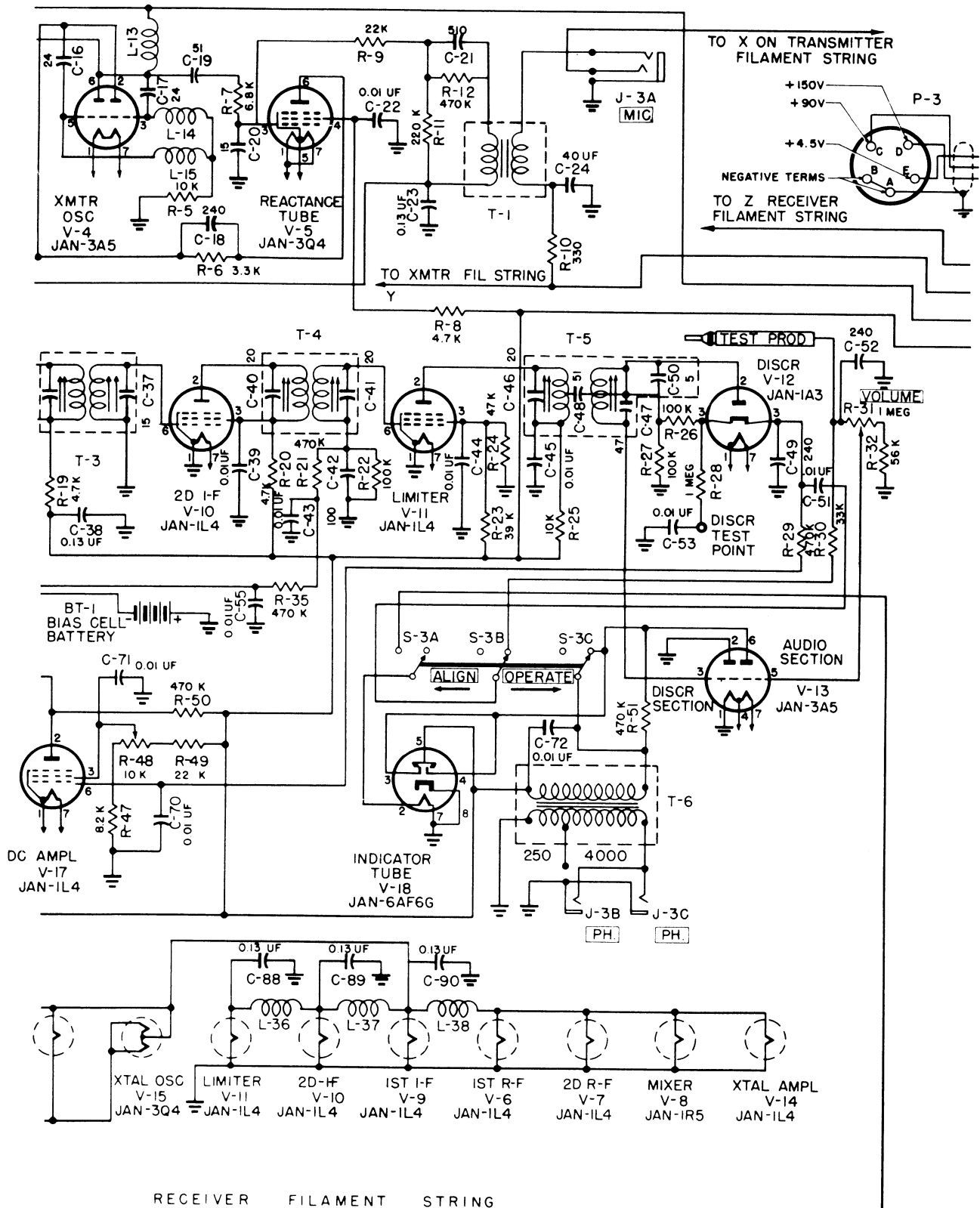


NOTE: CHANNEL SWITCH S-2A, S-2B, S-2C, S-2D, S-2E, S-2F, S-2G, S-2H, S-2J SHOWN IN B POSITION

Figure 95

SCHEMATIC, BC-1335-A, TRANSMITTER - RECEIVER

Diagram continued from page 82



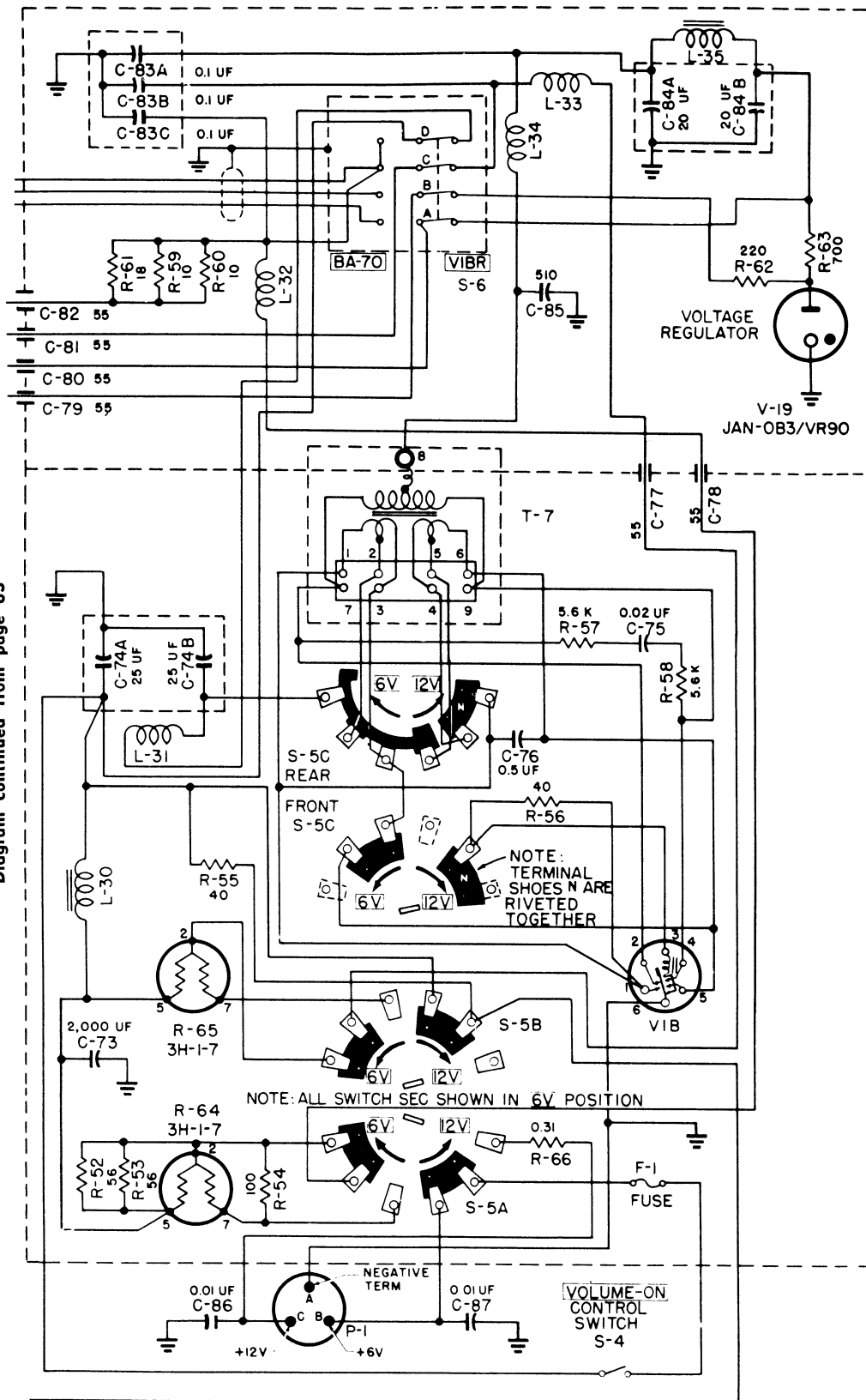


Figure 95 (continued)

SCHEMATIC, BC-1335-A, TRANSMITTER - RECEIVER

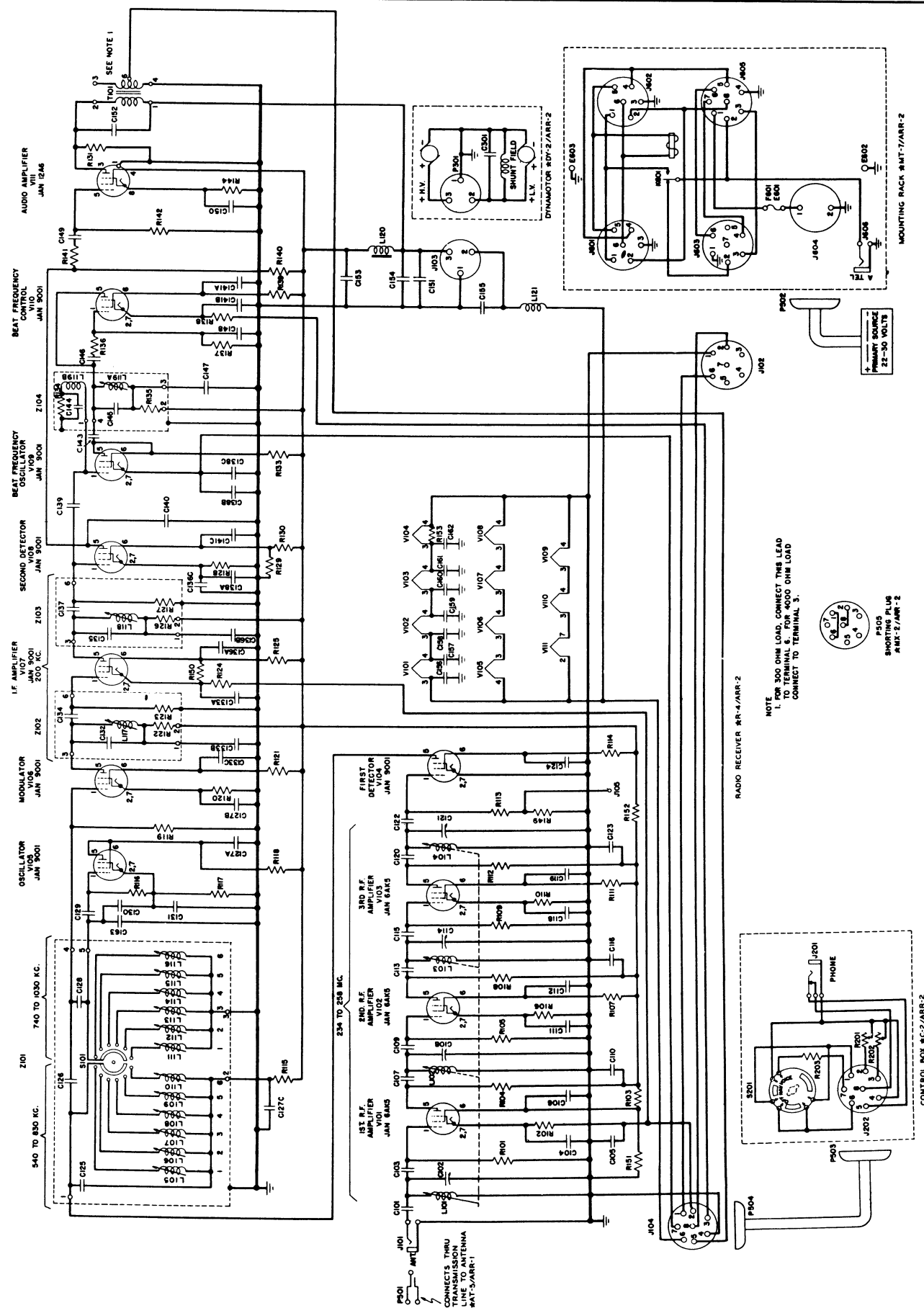


Figure 96
SCHEMATIC, AN/ARR-2 RECEIVER

Diagram continued from page 86

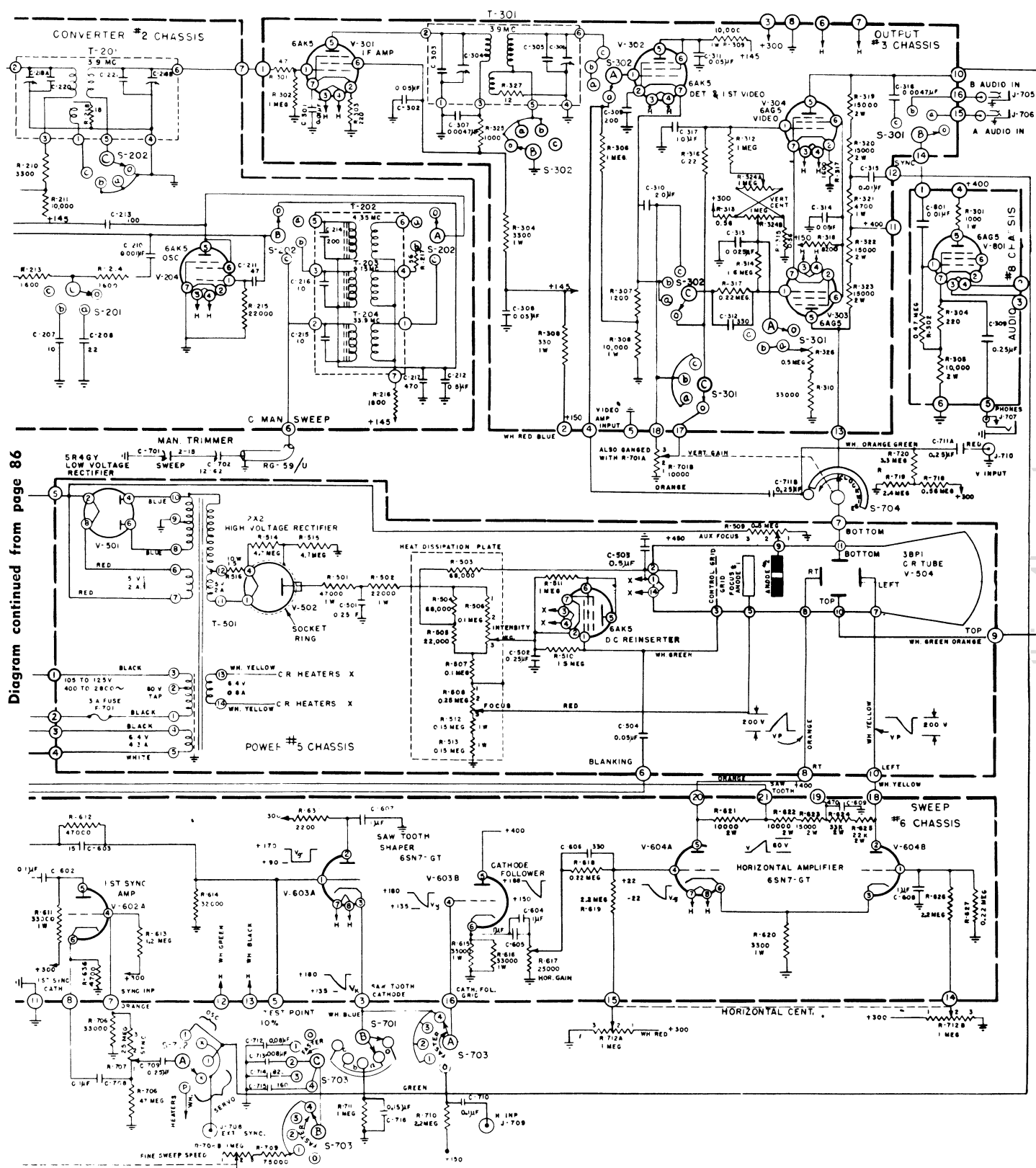


Figure 97
SCHEMATIC, AN/APA-10 PANORAMIC ADAPTER

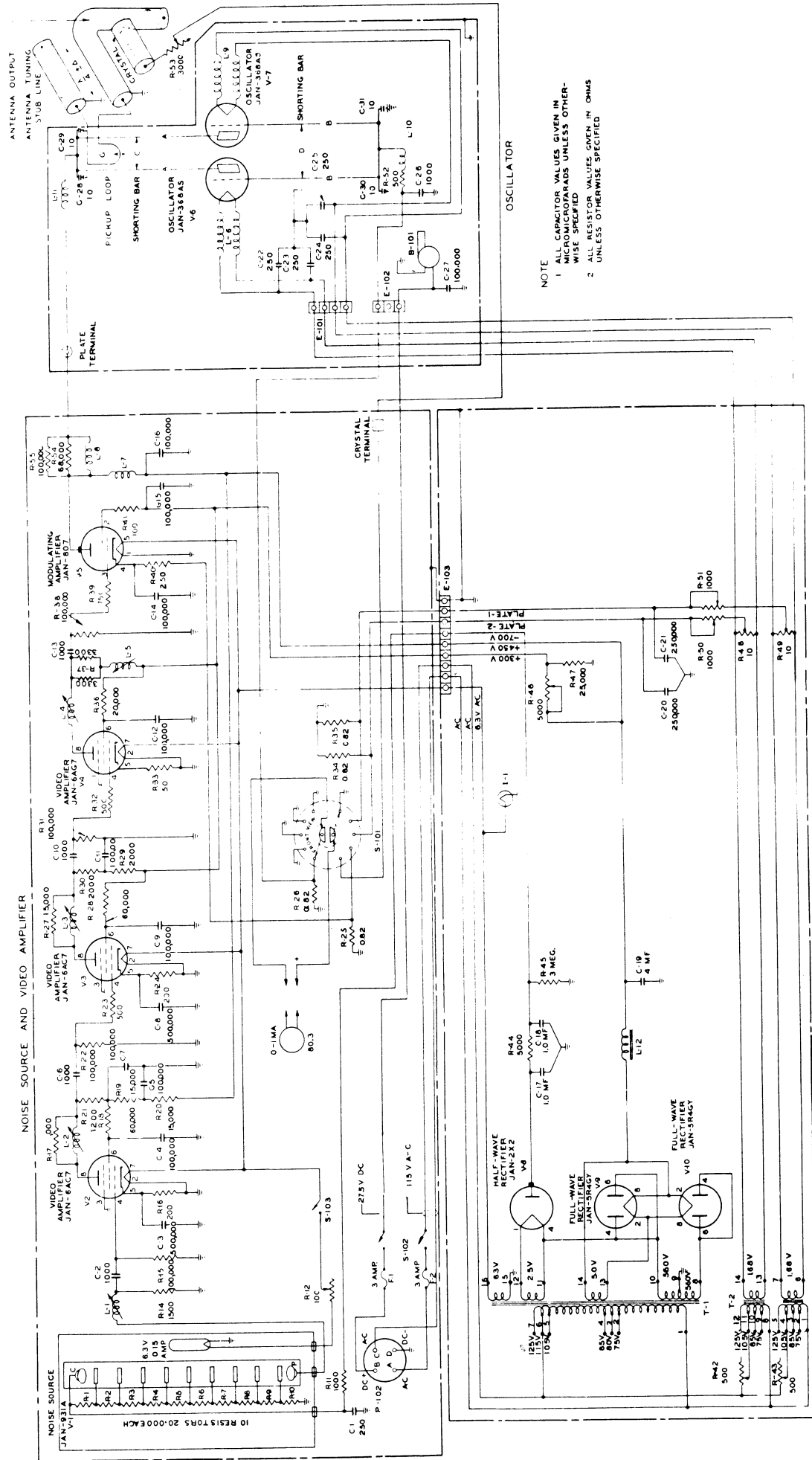


Figure 98
SCHEMATIC, RADAR SET AN/APT-2

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